

ECOLOGICAL PHILOSOPHY

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Arguments Thrive Where Facts Are Scarce

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ABBREVIATIONS

EAVP - The Ecological Approach To Visual Perception.
J.J. Gibson, 1979.

OLP - An Odyssey in Learning and Perception,
E.J. Gibson, 1991.

PPLD - Principles of Perceptual Learning and Development,
E.J. Gibson, 1969.

PVW_ - The Perception Of The Visual World.
J.J. Gibson, 1950.

RFR - Reasons For Realism,
J.J. Gibson, 1982.

SCPS - The Senses Considered As Perceptual Systems,
J.J. Gibson, 1966.

PREFACE : The Ecological Approach of J.J. Gibson

The ecological approach is attributed to James Jerome Gibson, 1904 to 1980. Gibson took a degree in philosophy before embarking on a career in experimental psychology. This philosophical background is essential to his ecological work.

Gibson regarded himself as a perceptionist. He attempted to cover the whole subject of perception and perceivers.

The historical starting point for the ecological approach was Gibson's observation of the differences between the laboratory environment and the circumstances of everyday life. These were made vivid in the course of his work with trainee pilots for the USAF during the Second World War.

In 1950 Gibson published "The Perception of the Visual World" (PVW). This set out his psychophysical theory of perception. Gibson became dissatisfied with psychophysics, agonising over why it was that such influential approaches failed to capture what is important about perception, namely what it is to perceive. The ecological approach emerged from Gibson's gradual rejection of his psychophysical ideas.

Gibson's published ecological work is contained in "The Senses Considered as Perceptual Systems" (SCPS), 1966, "The Ecological Approach to Visual Perception", 1979, and the posthumous collection "Reasons for Realism" (RFR), 1982.

To explore the ecological approach it is not sufficient to discuss the EAVP alone, for though the EAVP supersedes the SCPS in some ways, it complements it in other ways. In general, the SCPS deals with the senses in an ecological way whereas the EAVP is an ecological rewrite of the, psychophysical, PVW.

Gibson introduced and explored many ecological ideas in his seminar discussion papers. Thanks to the colour of the ink used and the nature of their contents these documents became known as "Purple Perils". In addition to this Gibson left a large number of unpublished papers relating to the ecological approach. These form part of the Gibson Archive housed in the Olin Library at Cornell University.

INTRODUCTION: Ecological Philosophy and J.J. Gibson

Ecological philosophy, as opposed to the philosophy of ecology, relates to the work of the ecological psychologist J.J. Gibson. In this work I seek to relate the ontology raised by J.J. Gibson to the concerns of ecological philosophy. This is more than a reiteration of Gibson's ideas for things have moved on considerably since the publication of the EAVP. In particular, we now have a situation where some of Gibson's ideas, such as the ontology of the environment, have become accepted and incorporated into experimental psychology and traditional philosophy of cognition. Alongside this there is a strand of ecological theorists in both philosophy, psychology and other disciplines who take ecological theory as their starting point and seek to develop it as a discipline in itself rather than incorporating it in any other practice.

It is prudent here to seek to take the ecological ideas which appeal to both strands, examine them in a strictly ecological way and to demonstrate the importance and value of these ideas. Once this is made clear it will be seen that to adopt the former, incorporative, approach is to invite confusion and contradiction in that given academic practice.

An Outline Of The Ecological Approach

There are common, traditional philosophical issues about perception. These split roughly into the description and explanation of perception (ontology) and into the account of perceptual knowledge (epistemology). The ecological approach yields significant theories in both areas. Gibson says,

"Perceiving is an achievement of the individual, not an appearance in the theater of his consciousness. It is a keeping-in-touch with the world, and experiencing of things rather than a having of experiences. It involves awareness-of instead of just awareness. It may be awareness of something in the environment or something in the observer or both at once, but there is no content of awareness independent of that of which one is aware."

- EAVP, p. 239.

One particular feature of the ecological approach is its explanation of perceptual awareness. It treats visual awareness at a high level of description and explains how it comes to be thus and so. Visual awareness is shown to be a matter of ecology. In short it is the relationship between the perceiver and the environment considered in strict, ecological terms.

Ecological philosophy may therefore be described in (what may be termed) a Strawsonian way as descriptive, analytic metaphysics in

that it seeks both to show the general layout of fundamental conceptual structures and to build from that an account of higher order conceptual capabilities. Thus for perception not only does it seek to produce an account in terms of such fundamental structures, eg recognition of simple optical invariants, but also provides an account of the meaning of what is so recognised in terms of the occurrence and use of affordances. In this way it is both ontological (relating to fundamental existence) and epistemological (relating to meaning).

Ecological approaches elaborate on the idea of reciprocity between organism and environment. This in turn is founded on an accurate description of ecological ambience. It rejects sensation based accounts as wrongheaded and physical explanations as, at best, incomplete.

The ecological approach is neither a physical nor is it a psychophysical hypothesis. Physics has not detected the kind of optical structure hypothesised by Gibson and other ecological theorists. The function of the senses is not to send signals to the brain. Nature does not seek to communicate with us. Furthermore, the physical and neurophysiological processes which are essential for perception are in no way computational processes.

The ecological approach engages spatial and temporal scales of description appropriate to animal life. It substitutes a description of nested natural units for the building block units of physics, geology and chemistry. Ecological motions are real events in real environments and are not reducible to the motions of physics. With respect to perception in its widest sense, surfaces, substances, and media are described in terms of higher order properties relevant to organism and behaviour.

Further to work in the philosophy of perception. the ecological approach addresses issues in the philosophy of mind and the philosophy of psychology. These too are to be put in an environmental context. In this way a whole ecological picture of perceivers comes about. The ecological approach seeks to be both fundamental and comprehensive and thus independent and free standing. In order to achieve this the ecological approach to perception offers new and important ideas about the ontology, epistemology, and phenomenology of perception and mind. It is founded on an ecological conception of the perceptual environment. The visual perceptual environment for instance is governed by ecological laws in general and by the laws of ecological optics in particular.

The ecological description of perception involves, indeed requires, the immersion of the perceiver in the perceptual information of the perceptual environment. For visual perception this involves optical

arrays, invariants, and affordances, which form the basis of the visual perceptual environment, accompanied by active, direct, unmediated perceptual information pick up, which results from the optic flow of this perceptual information.

The environment presents invariants to perceivers. These invariants may be picked up by perceivers. Higher order invariants determine what is available to the perceiver. They are determined and individuated by the perceptual flow which surrounds the perceiver.

When a perceiver moves in the environment some aspects of the perceptual array change while others do not. These transformations and invariants specify information about the environment, in particular they specify information about the layout of the environment and changes in this layout. In this way they are able to specify, perceptually, events within this environment.

Information pick up is not to be taken as a metaphor. Ecological perception is the pick up of perceptual information from the perceptual environment. In the ecological approach information pick up may loosely be said to play the sort of role often given to sensation in other perceptual theories.

Affordances are what the environment affords a perceiver. They are powers in relation to what an organism can do. Perceiving a chair affords a human perceiver somewhere to sit. A chair affords a perceiver the affordance "sittable-on". Affordances are given in virtue of pick up of perceptual information. To grasp an affordance is to perceive something in a particular way. This is not a process. It is rather direct and is not inferential. Once picked up affordances may be referred to and inferred from. Affordances are usually individuated in terms of what they afford the perceiver. Affordances play a role in the explanation of behaviour. One may make reference to an affordance in terms of behaviour. Affordances are both used by and are useful to perceivers of all kinds throughout all types of perception.

On the ecological approach perception is direct. Many philosophers and psychologists argue that perception is not direct. Uses of the term "direct" may differ. Directness on the ecological approach means that perception is not inferential and that it does not involve mediation. In particular it does not involve mediation by sense data.

That ecological perception is not inferential means both that perception gives knowledge of things in a way which is not the product of reasoning by the perceiver nor is it the result of computations performed within the perceiver.

With respect to the senses Gibson discussed the sense modalities and investigated the proper role and place of sensation in the SCPS.

On the ecological approach the senses are perceptual systems and sensations are associated with these systems. They are not perceptions or perceptual themselves. Sensations are the deliverances of the perceptual systems. The role given to sensation in sensation based theories has proved problematic whereas the role of sensations in the ecological approach is straightforward and logical.

The ecological approach embraces a realist theory of perception. Real objects are encountered in real environments by real organisms. Things really are for instance very much the way we see them. In this sense ecological theories may be said to stem from a naive approach. That ecological perceptual encounters occur directly relates ecological realism to ecological direct perception. Gibson himself referred to this position as naive realism.

The ecological approach is of instructive value wherever thinking about perception has come to focus on what is inside the head. The ecological outlook holds that much philosophy and psychology of perception has been led into a conception of visual perception that is too narrow to provide for a satisfactory account of perception itself. Thus the ecological approach offers valuable, liberating insights into the true nature of perception, freeing us, for example from the grip of the mechanistic picture of the mind.

The ecological approach holds perceivers to be whole organisms embedded in their environments and possessing every faculty required for perception. As such perceivers are in a position to be able to do what is necessary for perception. Such perceivers are neither computational systems nor processors nor algorithms.

Taken to its full extent the ecological approach offers a clear and deep understanding of cognition. Cognition in general and perception in particular are to be considered in terms of ecological information and not in terms of sensation or in terms of stimulus and response.

The ecological approach offers a new description and explanation of perception and of the mind. To understand the ecological approach fully is to understand the nature of mind in a deep and connected way. The ecological approach also allows us to appreciate the redundancy of many widely held theories and their attendant problems.

SECTION A : THE PHILOSOPHY OF THE ECOLOGICAL APPROACH

Chapter One: Ecology and Evolution

The word "ecology" comes from the Greek "oikos" meaning "house" or "home". Ecology is the study of homes, of habitats, and in particular the niche an animal or organism inhabits or takes up. The ecological description focuses on the organism, living and perceiving in its habitat, its natural home. On the ecological approach the concerns of perception and mind are what concerns animate ways of life. A way of life occurs in an ecosystem within an ecological niche.

Ecology is part natural science part academic art. Physics looks for laws, theories and models. It deals in generalities. History deals in specifics. It deals in particulars. Ecology offers a scientific approach to natural history. As such it deals in both specifics and generalities. Ecology is not objectively scientific. A general framework applies often individuated in terms of species or even a single species. Evolution offers histories of species. These histories are marked out by similarities and idiosyncrasies. In ecology there are ecological laws. Some of these are specific to species. In some ways ecology itself can be judged to be species specific. In this way ecology is both like a physical science and like an academic art.

Gibson took the term "ecology" from Egon Brunswik but adopted the meaning of "ecology" of the comparative zoologist Gordon Walls. For Walls ecology is the synthesis of physical, physiological and evolutionary forces. Ecological perception is a synthesis of selective physical, physiological, and evolutionary forces operating on the visual system, see G. Walls, *The Vertebrate Eye and its Adaptive Radiation*, 1942.

In this way Gibson took up an ecological stance insisting that perception is a question of a perceiver in an environment taken together. It is not something to be investigated by inspection of the perceiver alone. The ecological approach argues that perception is the detection of perceptual information delivered in by ecological circumstances and in virtue of certain ecological laws. These laws relate to the perceptual environment described in terms of the optic array. The optic array is completely filled with nested solid angles and this multi-nested structure undergoes both continuous and discontinuous changes. Gibson distinguishes between perspective and invariant structure in the optic ambience. The former will change as an observer moves about but the latter will change only as there is some change in the environment. Invariant optical structure underlies perspective structure and it is within changing perspective structure that invariant structure is embedded. These investigations constitute the body of work known as ecological optics.

The ecological description of the environment is essential to ecological optics. The structure of the environment determines the structure of stimulation, and the ecology of stimulation is the study of environment and stimulation relations. Perceptual systems and their activities are to be described at a level of analysis commensurate with the structure of stimulation and the structure of the environment.

The environment is tied to the perceiving animal in that it provides the conditions for perception and that it is what is perceived. Thus the environment is both epistemologically and ontologically connected to the perceiver. This takes place through the governances of the laws of ecological optics.

Ecological optics presents what is visual in terms of the function of light as a stimulus for the optical system. David Hamlyn has claimed that this is not enough for if it were then there would be no question of sensations ever obtruding on perception. Hamlyn regards an account of the way in which perception involves experience as ineliminable. Gibson agrees with this. It is however incorrect to suppose that we are given information in basic sensations which is then modified in subsequent experience. On the ecological approach modified sensations have no place in an account of perception, see D. Hamlyn, *Perception, Learning and the Self*, 1983, chapter 2.

The ecological approach is termed a direct approach because the perceiver perceives its environment as it actually is and does so by a reciprocal resonance, free from any intermediaries or circuitry. Knowledge of the world does not require any process of inference, or combination with memories, representations, images or other cognitive phenomena.

The ecological perspective of perception and mind may be made clear by reference to the concept of ambience because many common psychological explanations begin within the animal or mind. The ecological approach concerns what is outside the boundary of the organism's physical form yet always makes reference to the organism in describing the ambience in which life exists. The environment is a frame of reference both theoretically and psychologically. The ecological approach avoids reductionism (especially environmental reductionism and physical reductionism) by using the appropriate analysis of the environment and by tying physical ecology to animate life in terms of function.

The starting point of the EAVP is neither a phenomenology such as offered in the PVW nor an ecology of stimulation such as the SCPS, but a description and explanation of the ecological support for animate life. Ecological functionalism is tied to the idea of a surround or ambience which is necessary for behaviour such as locomotion, manipulation, and communication, and with ambient ambulatory perception. This holistic orientation is tied to the thesis that the

animal is not separated from the environment but supported and surrounded within the whole.

What is perceived follows from the ecological description of ecology. Instead of a list of perceptual qualities, such as depth, colour, shape, size, motion and so on, the ecological approach substitutes places, attached and detached objects, substances and events. This lists the environmental features relevant to animate life, see EAVP, pp. 240 to 242.

On the ecological approach to perception the objects of perception are what is perceived. These fall into five categories:

1) Places

Places or locations make up the environment. Some form a habitat for an organism, others are found to be hostile to the organism. Places are nested one within another. They have only imposed, artificial boundaries. Places are located relative to other places. Relative to an organism a particular place is rigid, it cannot change at all. Unlike an object, a place cannot be displaced.

2) Attached Objects

An object attached to a place is a substance partially surrounded by a medium. It is a protuberance with enough of a natural boundary to constitute a limit. Attached objects are individuated according to their limits.

3) Detached Objects

A fully detached object can be displaced either by itself or in some other way. Detached objects are otherwise the same as attached objects.

4) Persisting Substances

A substance is that of which places and objects are composed. They vary in grades of substantiality ranging roughly from the vaporous to the rigid. Substances are formless and cannot be counted. Their number is not fixed.

5) Events

An event is a change of any substance, place or object. Events are nested within super-ordinate events. Events are of different sorts and are countable in their own right. Events are not reducible to elementary motions.

With the assertion that ecological events are real in their own right the ecological approach opposes the common physical view of time as well as space. Just as physical space has no orientation and is merely an abstract system of co-ordinates so physical time is supposedly an arbitrary interpretation of physical motions or a statistical property of such motions. Physical motions are reversible *qua* physics but many ecological events *qua* ecology are not.

"The so-called irreversibility of time is actually the irreversibility of some, but not all, ecological events. It is simply not true that the only way of specifying the direction of time is by increase of entropy."

- EAVP, p. 101.

The ecological approach individuates what is perceived along the lines of how we learn to perceive the various things about us. So, if we learn to perceive p in a different way to q then p and q fall into different categories of what is perceived. A total description of how we learn to perceive gives both the ontology and the epistemology of what is perceived.

The ecological approach includes real organisms from its first consideration. The most important persisting objects in the environment are the animals which are unique among all objects in that they move under their own power. In addition to changing through growth they change through their actions. Animate creatures change the shape of their surfaces while yet retaining the same fundamental shape, see EAVP, p. 135.

With a few specialised exceptions, all animals move through their habitats, changing their positions while maintaining a persistent bodily integrity. Even simple animals are capable of perceiving an object, place, or event, that is its goal and of moving towards it. Hence every observer has not simply a point of view, but a path of view. These paths overlap and intersect. An individual's path of view changes continuously but the set of all possible paths of view is persistent. The environment of all animals is public and persistent.

The distinction between the environment of one animal and that of all animals underlies much of the theoretical development of the ecological approach. Through the application of the principle of persistence and change Gibson aimed to resolve questions about mind-body dualism and the problem of subjectivity, see R. Jander, "Ecological Aspects of Spatial Orientation", *Annual Review of Ecology and Systematics*, 5, 1975, pp. 171 to 188.

The ecological approach takes animals and environments together to form ecosystems. An ecosystem is characterised by a harmony of animals and environments wherein the animals have evolved and have learned to meet the requirements of the environment and reciprocally where the environment meets the needs of its animals.

The ecological approach requires ways and means to set out and constrain every facet of its exploration and inquiries. As there are physical laws so we require ecological laws.

To explain perceptions that involve the detection of behaviours afforded by the environment requires an understanding of the ecological relation between perception and action. This connection is given through the concept of an ecological niche for an animal in an environment.

The application of the concept of ecological niche can be made in biological, social or other terms. It is not restricted to a mathematical or scientific definition of position, place or locus. The ecological meaning of "position" is not only a location in space but also possible moves or actions of a position in a space. Possible moves or actions of the position mean not only moves in the space but also the social missions of the position in the social organisations such as in a large company, a school of whales, or a football team.

The term "position" not only has a static meaning such as location in space and social organisation but also a dynamic meaning relating to potential actions. A social organisation is mapped into a space. Social distribution or an activity is mapped into a space. There is no activity and action without a space for that activity or action, see EAVP, pp. 128 to 138.

In the terms of the ecological approach, a law is an invariant relation between or among substantial properties of things. The substantial properties can be either intrinsic or mutual. Laws are not reducible to law-like statements which for the ecological approach are conceptual reconstructions of invariant patterns. Law-like statements therefore need not overlap perfectly with laws and will not until their full formulation is achieved. Consequently they tend to apply only approximately and not to any arbitrarily established desired level of accuracy.

Some laws are causal whereas others are non-causal. Lawfulness itself is not reducible to causality and so we are able to begin work on the identification of laws at the ecological scale. This is the philosophical position of researchers investigating ecological psychology, see M. Turvey, R. Shaw, E. Reed, and W. Mace, "Ecological Laws of Perceiving and Acting", *Cognition*, 9, 1981, pp. 237 to 304.

Evolution in Ecological Perception

Theories of evolution and in particular evolutionary functionalism have had a powerful impact on the ecological approach. The ecological approach emphasises the veridicality of perception, environmental concerns, the functional understanding of perceptual systems, how the senses evolved to afford adaptation and the entire ecological theory of perception. These factors reflect the centrality of evolutionary considerations in the ecological approach. The central theoretical concept of the ecological reciprocity of the animal and the environment emerges in the context of evolutionary and functionalistic discussion.

The theory of evolution has made a significant impact upon the ecological approach. Evolution carries the dynamic approach to nature and ecology. Prior to Darwin each species was considered to be a separate creation (even where development occurred, it occurred separately) but evolution, adaptation and natural selection integrated natural forms, bringing them together in a dynamic interchange of co-operation and competition. This interchange is dynamic and ever changing, and although survival of the fittest and competition tend to be emphasised in evolutionary thinking, evolution involves progressive attunement, reciprocity and harmony between animals and the environment. The affordances of an environment are progressively exploited. Interchange is multi-levelled and multi-faceted. There are no static independent objects for the existence of an animal is an active and progressive harmony within an environment.

Evolution is relevant to our understanding of the compatibility and reciprocity of the animal and the environment. We need to explain how nature comes to be so harmonious and so ordered. The theory of evolution postulates that harmony and order arise within nature, rather than being imposed. Evolution rejects the dualistic split of order and particulars.

On the ecological approach the order found in the environment is tied to life. An environment only potentially exists prior to life. Though to a degree life creates new environmental order it is always implicated in the order existing in the environment.

The ecological approach is concerned with the veridicality and objectivity of perception. Perception is something real and objective. In the ecological approach the term "objective" takes on a new, ecological meaning. The environment is not an intrinsic substance. It is understood relative to animate ways of life. The reality, objectivity and invariant characteristics of the environment exist within an ecosystem involving life. The environment and the animal are reciprocal and evolution in reality is an ecological fact. It is not simply

a fact of life for it involves ecosystems that have evolved.

Studying perception in terms of evolved adaptations leads us to consider the most general and biologically significant ecological facts across species. This leads us to consider the environment of the organisms.

Both the optic array and the environment have been relatively invariant throughout evolution. From an evolutionary viewpoint, visual perception could be understood as an adaptation to the invariant and lawful optic array-environment relations. Insofar as ecological optics is an attempt to study these invariant relations of the optic array and the environment, its development is motivated by an evolutionary examination of visual perception, SCPS, chapter 9.

Following Walls, a function of visual perception may be defined with respect to the environment such as being able to perceive the total surrounding terrain or particularly well in one direction. Functional unity and co-ordination for a group of anatomical structures such as eye, head, and torso, and functional identity in different structures such as periscopy and no neck in one animal and frontal eyes with a flexible neck in another animal, are all central ideas within the ecological theory of perceptual systems. The inclusion of reference to the environment is necessary in ecological definitions of perception.

Animal and environment have always been united in nature. Theories of animals and environments need to reflect this. Uniting animal and environment for theory yields realism and a novel view of the sciences. The realism is one in which the real nature of the environment can be described with reference to the effectivities, that is the goal directed behaviours, of the animal.

The relationship between the psychological description of the animal and the psychological description of the environment is ecological. The ecological approach requires an evolutionary epistemology to make sense of evolutionary ontology. The full account of this is the responsibility of philosophy. Ecological evolutionary ontology inquires into the state, or states of being, of animals whose life and existence has been fashioned in accord with theories of evolution. Evolutionary epistemology is the inquiry into the epistemology of, and epistemological matters concerning, such animals delivered in consequence of theories of evolution. It concerns the epistemology of living animals.

The way to account for evolutionary ontology and evolutionary epistemology is in ecological terms. This is the task taken up by the philosophical account of the ecological approach. It is this philosophical account that delivers perception as ecological direct information pick up.

The ecological view is in some ways consonant with empiricism. This empiricism is tied to evolution and has been termed evolutionism. It is a keystone of ecological research. Evolutionism is based on the principle that only things that are compatible with one another can co-exist. With respect to epistemology this view is that the pragmatic knowledge of the environment that is an animal's actions upon that environment must be symmetrical with the affordances of that environment.

In the absence of a compatibility of effectivities and the affordances of the environment successful reactions to and actions upon the environment and thus animal life itself would not be possible. Animal actions continue to exist because of their compatibility with the affordances of the animal's ecological niche. Actions whether based in ontogeny (individual development) or in phylogeny (evolutionary development) could no more be incompatible with the environment and continue to exist than anatomical characteristics could be incompatible and co-exist.

Because actions exist as the expressions of pragmatic knowledge, they must be compatible with the affordances of the environment, see R. Shaw and J. Bransford (editors), *Perceiving, Acting and Knowing*, 1977.

In this way an animal's knowledge of the affordances of its ecological niche as specified by the information to the senses must be pragmatically true, where pragmatically true implies compatibility with the environment. The importance of experience or encounters with the environment in this scheme is apparent and as such it makes evolutionism a species of empiricism. What sets evolutionism apart from empiricism is the question of on whose experience knowledge is based. Empiricism relies solely on the individual animal's experiences whereas evolutionism includes the experiences of the animal's progenitors as the necessary basis of the ability to occupy the appropriate ecological niche. Pragmatic knowledge is so rooted not only in encounters that an individual animal has with the environment but also in encounters, both successful and unsuccessful, by which its progenitors rather than their relatives were selected in the evolution of the species.

In both phylogeny and ontogeny the acting animal and the niche can continue to co-exist to the extent that actions are compatible with what the surrounding substances and surfaces afford. To the extent that the act and the niche are not compatible they cannot co-exist.

The ecological approach does not equate compatible and true. The ecological claim is not that perceptions and actions are correct. It is that they exist and to exist is to provide evidence for compatibility.

Perception and action cannot be labelled correct or true for in order to be so they would have to be propositional. The ecological approach holds that perceptions and actions are not propositions nor are they based on propositions and therefore they cannot be either correct or incorrect. In this the ecological approach is a form of philosophical naturalism.

To argue for the claim that perceptions and actions are not propositions is to apply to an animal's knowings the same logic that is applied to an animal's anatomical attributes. States of psychological affairs including knowledge are to be treated in the same way as states of biological affairs for there are strong parallels between pragmatic knowledge as a psychological state of affairs and anatomical structure as a biological state of affairs.

Though the characteristics of perceivers can be put into the form of propositions this does not make the perceptions themselves propositions. To make them so invites conceptual difficulties for instance over who is making the propositions. The disappearance of anatomical attributes, whole animals, and species as a function of natural selection does not permit one to judge that they were false. Likewise the disappearance of an action or even of the animal through a fatality does not render that action or the pragmatic knowledge it expresses false. They are rather states of affairs that are or came to be incompatible with the environment. In this way the ecological approach holds the from-no-particular-time view of systems analysis.

The goal of the ecological approach is to put knowings on the same metaphysical level as anatomical and biological characteristics. They are states of affairs which may prove to be incompatible with other states of affairs. The psychological states of an animal, like its anatomical features, must be compatible with other states of affairs for the facts of the environment stand in a reciprocal relationship with them. They should not be thought of as propositions about the environment.

Consider the example of a bird that flies into a window. We can try to state in words what the bird thought before impact such as "fly there". It is the interpreter that makes propositions about the state of affairs. The state of affairs itself is not a proposition. Because the principle of compatibility is linked to co-existence, the state of affairs that is the bird's knowledge, here its proprioception, will co-exist momentarily with a broken neck. Compatible psychological states of affairs in animal and environment can co-exist. Incompatible states cannot co-exist. This is a rule of ecological logic.

The relationship between compatibility and co-existence is an ontological claim supporting two parts of the ecological approach. First, evolution is the term applied to the particular manifestation of

compatibility and co-existence which results in animal-environment systems and thereby ensures the compatibility of pragmatic knowledge and reality among species. Second, learning is the term applied to the particular manifestation of compatibility and co-existence that results in specific animal-environment systems and thereby ensures the compatibility of pragmatic knowledge and reality for the individual animal.

Chapter Two : Invariants and Affordances

Invariants in the Ecological Approach

Invariants play a central role in the ecological approach. Perceptual invariants are an important part of the ecological description and explanation of perception. In perception information is picked up in virtue of perceptual invariants. These are features of the environment such as dark objects. They may be expressed in terms of fixed mathematical relationships but they stand for much more. They are not raw data ready for processing.

Though throughout the evolutionary history of life there have existed certain constants, invariants themselves are relative for nothing is absolutely permanent. The environment is dynamic and exhibits a variety of spatial and temporal transformations. The environment possesses indeterminate richness of structure. This is shown up by the invariants of the environment.

Invariants are associated with and shown up by variation and change. They are higher order properties of patterns of stimulation which remain constant during changes associated with the perceiver, the environment or both. As such they are selected by superordinate or higher order perceptual systems. One task of the perceptual system is to abstract these invariants. This abstraction is the detection of invariants across objects. The invariant is therefore a similarity. It is not a persistence in the object, see EAVP, p. 249.

Invariants are what the environment presents to a perceiver. They are graspable by perceivers. They determine what is available to the perceiver. They are determined and individuated by the optic flow which surrounds the perceiver.

Invariants are features of the optic array. They are not simply mathematical entities for they are perceptual. They are not affordances though pick up of an affordance involves pick up of certain invariants.

Invariants are fixed relative to features of other invariants. They are not fixed to a set of objects but rather to a set of contexts or environments. Invariants are invariants with respect to a particular context or to a particular set of contexts. With respect to visual perception, the structure of optical invariants is quite simply whatever optical pattern persists despite the changes of perspective structure. For example, no matter how a terrestrial observer moves the horizon is always the limit of all gradients of a texture density, and it always separates the ground from the sky. There are indefinite numbers of such invariants.

The ecological invariant relates to the ecological importance of motion in perception. Invariants give the environment stability and provide a framework for living. There are spatial invariants such as gravity and the contrast between earth and sky, and there are temporal invariants such as the seasonal and diurnal cycles. These invariants are invariant contrasts or relationships of differences.

In environmental situations the shapes of surfaces are commonly perceived veridically without the surfaces of objects having to move. Perceptual veridicality in an environment of stationary objects is ensured by the fact that the perceiver normally moves about and explores the environment. The optical invariants specific to a surface shape can become effective through a sampling of optic arrays. There is a need for an active perceptual system in the veridical visual perception of surface shape. Perceived shape is a relatively permanent property and is not based on a static property such as form but rather upon an invariant embedded in change, see J.J. Gibson and E.J. Gibson, "Continuous Perceptive Transformations and the Perception of Rigid Motion", *Journal of Experimental Psychology*, 54, 1957, pp. 129 to 138.

The isolation of invariants by a perceiver is not an all or nothing, or once and for all, matter. Physical objects have more than one face or side and correspondingly there are invariants specific to each of these surface shapes. These invariants are not registered at once when the perceiver moves, but may require for their isolation various exploratory activities. The perceiver may not look at every structural characteristic of an object and consequently may not perceive all of them. The more the perceiver explores the greater the number of invariants isolated and the more of the object is perceived.

Geometry provides the tools to describe invariants mathematically. Invariants are properties that tolerate certain transformations without changing. Invariants together with the allowable transformations give the geometry of perception or what is termed "information space". Information space, as structures and transformations, provides the basis for describing events, namely changes wrought over objects. Structures and transformations can both be invariant. Structural invariants are properties that are constant with respect to certain transformations while transformational invariants are those styles of change common to a class of transformations that leave certain structures invariant, see M. Hagen, *Varieties of Realism*, 1986, Chapter 2.

Invariant structures in light and sound not only specify objects, places and events in the environment but also the activities of the organism. Speed and direction of locomotion for instance, are specified by the optical transformations at the eyes. In virtue of the laws that support them, invariants are information about the environment and the relation of animals to that environment.

Spatial and temporal invariants correspond to permanent properties of the environment. They constitute information about the permanent environment. The brain functions so as to detect invariants despite changes in sensations of light, pressure or loudness of sound. The function of the brain when looped with the perceptual organs is not to decode signals or to interpret messages nor is it to accept images or to process data in computational terms. The function of the brain is to seek out and extract information about the environment from the flowing array of ambient energy.

A compound invariant as a unique combination of invariants is just another invariant. If the visual system is capable of extracting invariants from the changing optical array then it is capable of extracting invariants that strike us as highly complex.

Apart from structured invariants the ecological approach proposes formless invariants as information for the perception of objects. These formless invariants of optical change specify an object's integrity, its shape and its rigidity, see EAVP, pp. 173 to 178.

On the ecological approach invariants can be granted according to different sets of constraints. Some invariants require fewer constraints than others. There are constraints that are ecologically universal holding throughout the relevant environment. Informative properties that rely only on such constraints are complete invariants. Several of the informative invariants that have been studied are examples of complete invariants in this sense. The constraints they rely on are laws of nature and general characteristics of terrestrial environments such as the flow field properties analysed by D.N. Lee, see D.N. Lee, "Visual Information During Locomotion", in R. MacLeod and H. Pick (editors), *Perception*, 1974.

It is possible to consider proximal (central) properties that would be specific to something distal (surrounding) if some further constraint or constraints should apply. Such properties give ecologically incomplete invariants. Incomplete invariants are granted by constraints some of which do not apply throughout the relevant environment. A looser way of defining an incomplete invariant is to say that it is a property that differs in some way from a complete invariant but nevertheless has specificity for some subset of the cases that occur in the environment. Considered across the entire ecological environment it would provide some proportion of correct and false information while within some more or less discernible local region where some additional condition is fulfilled it has full specificity.

The distinction between complete and incomplete invariants is not sharp or absolute but varies depending on how we delimit the relevant environment. We may for instance wish to analyse the

general environment or we may focus on the environment of a particular species or individual or on a particular task situation. The insight about the close dependence of invariants on constraints captures the flexible nature of the informational value of many proximal properties. In this way a rigorous study of wide ranges of perceptually relevant information is possible.

The ecological approach has the advantage of showing that there are complete invariants which are relevant to perception and which have been empirically shown to be effective in perceiving. There remains a need to explore properties that have more narrow ranges of invariance. Studies within biology show that there may be a large surfeit of informative properties on any given occasion. Their domain of invariance extends far beyond the ecological range. Philosophers of perception need to account for this. It is possible that other invariants dependent on further constraints over the ecological environment. They will then be complete invariants and be equally potent as parts of the informational resources available to perceivers.

The structured media that surround us also make available proximal properties that have the character of ecologically incomplete invariants. There are several reasons and ways that actual perceiving might occur on the basis of such proximal properties,

- a) The kind of perceptual system available may not be suitable for the pick up of a particular complete invariant that is available.
- b) Due to the nature of perceptual systems or the individual's history of perceptual learning, certain incomplete invariants may be more easily or more quickly picked up than their complete counterparts and therefore may be relied upon in actual perceiving.
- c) For the same reasons, properties that are not complete invariants may be discovered earlier in the process of acquisition of a perceptual skill. Incomplete invariants may be in use at intermediate stages of perceptual learning later to give way to the use of less incomplete invariants.
- d) The cases in which the use of an incomplete invariant leads to mistakes may be few or innocent enough to make it practically useful nevertheless.

These points pertain to cases where perception occurs on the basis of incomplete invariants with less than perfect performance as the necessary result. It goes some way to explaining what are usually referred to as "misperceptions".

Ecologically incomplete invariants may be rendered effectively complete where,

- 1) The individual has not gone outside the local region within which an incomplete invariant is fully invariant. Until they do perceptual performance will be as well supported as is can be and there will be little incentive or opportunity to discover a complete invariant.
- 2) The perceiver may use an incomplete invariant when inside the relevant local region and to switch to a different invariant or remain perceptually uncommitted, when outside it. This can occur whenever the limits of the regions or the prevalence of the constraints are specified by some information.
- 3) Alternatively there is the possibility of a merging or concatenation of a few ecological incomplete invariants by means of information specifying their regions of applicability into an effectively complete invariant.

The notion of incomplete invariants provides the ecological approach with a conceptual tool for handling cases of perceptual proficiency in specific situations as well as cases of generally low or intermediate levels of performance. This is in addition to the possible role of imperfect precision or the gradual emergence of specific sensitivity in the perceptual pick up. In this way there need be no conflict between the facts of progressive improvement in perceptual learning and the notion of perception as the pick up of information in the form of invariants.

The introduction of incomplete invariants suggests a mechanism for the acquisition of perceptual skills that preserves the notion of invariant pick up for each stage of learning and each instance of perceiving. Improved performance can result either from the discovery of more complete invariants or from the use of concatenated invariants that consist of incomplete invariants together with information that specifies the conditions for their respective applicability. It emphasises that exposure to less constrained conditions should provide both motivation and conditions for the discovery of better invariants.

It may seem that incomplete invariants fit the conventional notion of "cues". Here particular perceptions occur as a result of the presence of certain factors or cues in the perceiver's perceptual ambit. Some well known cues could be interpreted as incomplete invariants. The invariants of the ecological approach differs in some important respects.

First, it is not the case that all available informative properties are ecologically incomplete invariants. Their introduction occurs instead in respect of the proven existence and effectiveness of complete invariants. This provides no support for the argument that constructive or probability based inference processing has a necessary role in perception. Second, the incompleteness of

incomplete invariants is not due to inherent randomness in the relation between distal and proximal properties. Probability as a measure of degree of correspondence alone fails to capture the ecologically relevant nature of incomplete invariants and so is unable to gauge their utility. Third, it is not true that ecologically relevant incomplete invariant properties must be analytically simpler, divided into lower and higher order variables, or that they must be more readily describable in the terms of conventional, for example those of lower and higher physical dimensionality.

The notion of ecological invariants is specific to the ecological approach. It stands apart from the terms of other theories. Philosophers, and others, have long sought a satisfactory explanation of how perception works in terms of the way perception seems to the perceiver. This ecological consideration of the “how” of perception, mechanism gives many of the steps, avoiding many of the potential pitfalls, towards just such an explanation. It is with this in mind that Gibson’s notion is developed further below.

Invariants and Transformations

Ecological optics is the study of optics in the environment concerning the specific relations between invariants and transformations of the optical array and the persisting and changing properties of the environment.

The optic array has structure at all levels of analysis. Its most global patterns consist of parts which in turn have pattern. These patterns of parts also have parts that have pattern and so on, beyond the limits of visual acuity. Any region of the optic array, no matter how small, is never a simple point but has shape and internal differences. Whenever the observer moves any such region of structure does not move in just one direction but undergoes a transformation of pattern in all directions.

Every optic array is unique to its station point in the medium. There is a unique difference between any two optic arrays that is projectively specific to the change of position of the perceiver relative to the environment. Consequently the position and change of position of the observer in the environment is always specified in any sampled optic array. In this way the ecological approach systematically ties perception and proprioception together and provides a description of ecological sensitivity.

Deformation in the optic array is described in terms of the relations of transforming structures. When a perceiver moves about the environment the transforming optic arrays sampled do not just contain invariants. The fact of transformation means that something is variant. While optical invariants constitute information about environmental permanency, optical variants constitute information for

environmental change and changes in observer position relative to the environment. In this way ecological invariants may be distinguished from ecological variants.

In the ecological understanding of the perceptual spatial framework invariants of transformations are very important. Veridical perception of surface shape is one case where the activity of perceiving involves optical transformations.

Invariants and transformations of the transforming optic array are univocal whereas structure in the static optic array is often equivocal. This is shown up by the distinction between transformational and structural invariants. This distinction deals with many cases of perception that form the basis of philosophical problems over optical illusions.

Transformational invariants are patterns of change which can reveal what is happening to an object where for instance an object moving away from us at a constant speed has a lawfully diminishing apparent area. The apparent area varies with the size of the solid angle subtended at the eye and the decrease in area varies with the square of the distance. When this relationship is present the distance between us and the object changes in a regular manner. Departures from this invariant occur either with a change in the rate of movement or with a change in the size of the object. With transformational invariants the source of information is the style of change.

Structural invariants are higher order patterns or relations which remain constant across changes in stimulation. For two objects of the same physical size at different distances from a perceiver the visual angles subtended by the object are different. This raises the problem of size constancy which asks how we can know that two or more objects are of the same physical size. The ecological approach explains this in terms of an invariant property of the stimulus array which specifies that the objects are of the same size. The ratio of the height of an object to the distance between its base and the horizon is invariant across all distances from the perceiver. This ecological analysis of light in the environment yields a solution to the problem of size constancy. What is not shown is that it is this property which serves as information specifying that the objects are the same size.

The Scope of Invariants

Ecologically significant invariants may be universal or local. Universal invariants span animal and environment systems into which members of a species enter. Local invariants may be unique to a particular animal and environment system. It is expected that there should be genetic pre-attunement to universal information. This is evidenced by reflexes or fixed action patterns. The animal must

learn to detect local invariants. Though learning is needed, evolution often gives animals a head start in terms of the kinds of energy structures to which they should be sensitive.

Different perceptual invariants are specified by various pieces of stimulus information. To assign different invariants to the same pieces of information is to redescribe the perceptual landscape. In this way there may be disagreement about the salient points in any given perceptual situation.

Another problem for the perceiver is how to detect new perceptual invariants. This is highlighted by our empirical investigations of a perceptual system. For example to find out which animals are sensitive to infra-red radiation requires careful experimental studies. All the variables need to be controlled if we are to isolate infra-red radiation as the correct invariant. Observation of real life situations does not permit invariable constraint and so may be less successful than performing controlled experiments. The richness of the ecological conception of perception involves an unmanageable number of variables. With the concept of the invariant this becomes theoretically simple and flexible.

The concept of the invariant enables the ecological approach to give a basic account of perception. This runs counter to the constructivist position which has no invariance but only variance connected to phenomena. For constructivists, such as Richard Gregory, perception is a construction of raw, low level data, and the result of a hypothesising, inferring or computational mind. The ecological approach denies such construction any place in perception. Invariance and transformation are reciprocal concepts. Ecological invariants do not take part in causal relationships but rather share in a relationship of ecological, reciprocal resonance.

The coherence of the perceptual experience is explained by an understanding of perceptual awareness. Perceptual awareness occurs through the pick up of perceptual invariants across the whole ecological context. Perceiving the continuity of the surrounding scene, where things are relative to each other and to how they fit into a meaningful whole, does not require a filling in or a connecting together by the mind. The pick up of invariants alone is sufficient to specify perceptual continuity and coherence within the organism's environment.

While an account of invariants and all that invariants specify is necessary for an appreciation of perceptual information it is not sufficient. Invariants alone cannot provide perceptual information to an animal that does not have the biological machinery or prosthesis to detect them. There is a further set of arguments for the inclusion of the animal and the notion of information in perception. This

involves the exploration of the environment and the pick up of affordances.

Affordances

On the ecological approach the basic fact of vision is that a perceiver perceives a portion of the entire environment. In seeing our surroundings we do not see abstract geometrical surfaces, colours or isolated physical objects. What we see, at the level of what we see, are the affordances of things. The fact that we see our surroundings means that the awareness of these affordances is the basis of our knowledge. A full, satisfactory, theory of affordances ties together our understanding of awareness, action and knowledge. As such it is of the utmost importance to philosophy, see for instance J. Sanders, "Affordances: An Ecological Approach to First Philosophy", in H. Haber and G. Weiss (editors), *Perspectives on Embodiment*, 1997.

Affordances explain how perceivers perceive what they perceive. An affordance is a perception which reveals some way in which the environment may afford some thing for the perceiver. The general form of an affordance is,

Affordance a affords perceiver P disposition d ,

where the disposition is of the form,

that P can ... (eat/sit on etc) a ... (banana/chair etc).

Affordances are quite different from perceptual invariants. Affordances stand over and above invariants and neither replace them nor are re-descriptions of them. Invariants are features of the environment picked up by suitably able perceivers whereas affordances relate to abilities of perceivers to be found in and to be picked up from environments. There is nonetheless a close, reciprocal, relationship between them for as the notion of invariant revolves around the relationship between environment and perceiver so the notion of affordance revolves around the relationship between perceiver and environment. Thus the invariant information of the environment has a value for the perceiver in virtue of being afforded to the perceiver.

This value may differ for instance in a desert environment where perceiving a pool of water has a high survival value compared to a park environment where perceiving a pool of water has a lower survival value.

Organisms pick up affordances appropriate both to the organism and to the perceptual information itself. Nothing else need be added and no processing need be done. Affordances are dispositional and often show up in the behaviour they afford the organism.

An affordance is a combination of properties of substance and surface taken with reference to an animal. One combination of properties affords grasping another affords support for upright posture another affords catching and so on. Other combinations are said to afford interactions or relations, a predator for example at a critical proximity may be said to afford danger.

The guiding principle of investigation in the ecology of the environment is to ascertain what the environment affords the animal. The facts of the environment described are selected for their relevance to behaviour and perception. The ecological description of the environment sets the stage for the investigation of perception and of the mind of the perceiver.

The world the animal perceives and behaves within is commensurate to that animal in spatial and temporal scale and more importantly in terms of its affordances. The set of affordances available for the living animal constitutes the environmental niche. The dynamic and functional complementation of the environment to the animal constitutes the set of affordances of the environment. Complimentarily, the psychological facts of the animal are functions ecologically tied to the affordances of the environment, see EAVP, pp. 127 to 129.

Animals have evolved to perceive those aspects of the environment which stand in a functional relationship with them. These aspects are affordances. This is possible because affordance properties are structured in ambient light and also because animals have developed sensitivities to this structure. Information as the structure of ambient light and the corresponding structure of perceiving functions, makes the perception of affordances possible. Using the concept of information in this dual sense is the only way to preserve the relational character of affordances and the reciprocal relational and non-dualistic doctrines of the ecological approach in general.

Affordances refer to the meanings of features of the environment. They are what the environment furnishes for animals and they are perceived directly. Affordances include graspable and manipulable objects, dangers, edible substances, places to hide or to be sheltered from the weather, the ground to walk on, weapons and fuel for heat. Affordances are understood relative to living forms. The affordances of the environment are ontologically tied to the animal in this fundamental way.

A perceiver is not compelled to use every affordance perceived but because it is ecological perception is never divorced from motive. In the affordance based theory of motives there exist a multiplicity of drives not simply the avoidance of pain and the seeking of pleasure posited by all sensation based theories. Each perceived affordance

has its own meaning and use, and for each observer it has its own unique cluster of motivating values.

Many reasons and many motives pertain to external objects, events, places and people. A reason and a motive takes on an external character when a perceiver picks up information specific to the relative properties of the external things. Affordances are external in the sense that they provide a reason or motive for action even when a perceiver is unaware of them. Some of the affordances detected may be natural in that they are to do with the ecology of our lives and some may be cultural insofar as they are concerned with historical or sociological meanings and values. Both affordances and information pick up are rooted in the direct perception of the environment.

The functional relationship between the animal and the environment shows up in the concept of the affordance. The ability of an animal to operate successfully in an environment is dependent on its perceiving those conditions which have functional significance. Affordances refer to the attributes of the environment in terms of their consequences for the animal. The perceptual systems of an animal can be seen as having evolved to enable the animal to perceive the affordances constituting its ecological niche. Gibson gives the following example,

"If a terrestrial surface is horizontal (instead of slanted), nearly flat (instead of convex or concave), sufficiently extended (relative to the size of the animal), and if its substance is rigid (relative to the weight of the animal), then the surface *affords* support. ... It is stand-on-able, permitting an upright posture for quadrupeds and bipeds. It is, therefore, walk-on-able and run-over-able."

- EAVP, p. 127.

Whether a surface affords support depends on the attributes of the surface and of the organism. Thus a water surface does not afford walking for a human but it does afford walking for some types of insects.

An affordance is not an attribute of the environment. An affordance implies the complementarity of the animal and the environment, and is equally a fact of the environment and of behaviour. The relational character of affordances shows up in differences between species too. For example, a small space affords shelter for a child, but not for an adult. In this way an affordance is a fact of the environment taken with reference to the attributes of the perceiver and so it is a relational concept.

The basis for the perception of an affordance are the basic properties of the environment that make an affordance. These are specified in the structure of ambient light and hence the affordance

itself is specified in ambient light. Affordances can be specified with reference to the informational structure of the environment. They involve a unique combination of invariants.

Substances change through time whether over many years or instantaneously. Whatever else, visual perception is a matter of the particular invariants that we perceive on a given occasion. It is these that give affordances and it is the affordances that have value for us. Their value is a substantial value rather than a mere abstract numerical value. This value may change. In day to day life there are many instances of this value changing even for the same substance, I think for instance of the different affordances you have picked up from a piece of string.

The perception of affordances as opportunities for and consequences of behaviour is what matters to perceivers. The perception of affordances is to be specified with respect to these factors in the following sort of way. Consider a large boulder rolling towards you. You would like to know when it will arrive but that is not all that you want to know. Time-to-contact information considered in isolation is of no use. Knowing when the boulder will arrive is useful only if you can do something about it. The behaviours available depend on more than the boulder's motion relative to you. They are a function of properties of the situation other than the boulder, properties of the ambient environment and of the self. If you are standing on a flat, level, extended surface of high friction you may be able to simply step out of the way, assuming that you are not excessively fatigued, have the use of your legs or other means, and so on. If the surface of support has other properties, if for instance it is very slippery the affordance for stepping may be absent and some other behaviour may be required. Perhaps there is no surface of support. If you are in water you may be able to escape by pushing against the medium of support that is by swimming. If there is no support at all, if you are weightless, there may be nothing that you can do to avoid or to mitigate collision. These properties of the situation and their influence on your affordances for action will not be specified solely in stimulation of individual perceptual systems and they will not be specified redundantly across systems. Thus in order to detect the totality of the event specified as the boulder approaching you, you must detect the pattern of stimulation across visual, vestibular, auditory, and somatosensory systems. This intermodal pattern specifies the affordance of this situation and may so be investigated by experiment.

Through a classification of affordances the functional dimension to the environment is tied reciprocally to the animal and the structural and substantial features of the environment. Affordances refer environments to animals and may be grouped together as supporting locomotion, concealment, manipulation, nutrition and social interaction. Before more specific features of the environment are

perceived affordances are detected by perception so that the environment is fundamentally perceived as affordances. Affordances can also be divided into positive and negative for if the environment supports life it also embodies features that can harm or destroy life. Affordances exist in a dynamic ecosystem involving living and dying, life and death.

Affordances tie together the structural, chemical and functional features of the environment. In this way they tie ecological space and ecological time together. Both are treated as an empirical reality that is manifested concretely through a specific environmental feature namely layout for space and events for time, see J.J. Gibson, "Events are Perceivable but Time is Not", in J. Fraser and N. Lawrence (editors), *The Study of Time*, II, 1975.

Affordances are specific ecological functions of structural and chemical environmental features manifested in ecological events. Spatial and compositional features of the environment are relative ecological constants and affordances persist to the degree to which these constants persist.

Affordances suffer rigorous constraint both from the environment and from the animal. Affordances are not merely species specific nor do they depend solely upon the particular abilities or disabilities of an individual. A single object may offer more than one affordance. An apple, for instance, affords grasping, throwing, eating and fermenting. It is not correct to consider affordances as reducible to invariants for affordances are the meanings that an environment has for a perceiver.

That more than one affordance can be seen from the same part of the perceptual environment focusses on two issues,

- a) The same object can afford more than one thing, and
- b) Different types of perceiver may pick up different affordances from the same perceptual environment.

These issues come together in the following example. Consider a child and a goat. There is a bonnet lying on the ground. The child kneels so that its head is next to the goat's head. Both look at the bonnet on the ground. The child sees that the bonnet affords clothing, or warmth, or protection from the wind, or ease of parental distress and so on, as required by a). The goat sees the bonnet affords food. Both perceivers together give requirement b). There is no necessity that either child or goat picks up any such affordance. In such a way,

"The theory of affordances implies that to see things is to see how to get about among them and what to do or not to do with them."

An affordance is equally a fact of the environment and a fact of behaviour. It points both to the environment and to the observer. They are not phenomenal qualities of subjective experience. They are real properties of the environment relative to an animal. They imply the complementarity of an animal and its surroundings.

The ontological character of an affordance holds that,

1) Affordances are real possibilities.

They occur in real environments with real perceivers.

2) Affordances are dispositions.

In the most general case an affordance will be comprised of a configuration of substantive properties.

3) Affordances are complemented by effectivities (see below).

Affordances may deliver sophisticated forms of ecological perceptual content. To know and describe even straightforward affordances is a formidable task. The problem is that if an object in the world affords eating say, then it is not clear just what in the optic array makes this affordance explicit. The ecological approach says simply that it is the particular nested array of solid visual angles. This does not seem to reveal the relevant characteristics of such a complex array. Even if we are able to define the affordances delivered to a perceiver we would still seem to be unable to predict the behaviour of that perceiver.

In ecological theory organisms may learn to attend to particular affordances. To predict behaviour we must know what affordances are available and to what the perceiver is currently paying attention. Affordances are always relationships between organisms and their environment. Their behavioural ramifications flow from this. Ecological theory is such that without the presence of the environment there is no use for the notion of affordances.

Effectivities

There is a close, reciprocal relationship between affordances and effectivities for where affordances may be defined so,

AFF) A situation or event X affords action Y for animal Z on occasion O if certain relevant compatibilities between X and Z obtain.

Effectivities may be defined so,

EFF) An animal Z can effect action Y on an environmental situation or event X if certain relevant mutual compatibilities between X and Z obtain.

Thus it may be seen that effectivities supply the complementation required by the theory of affordances.

Where an affordance is a disposition of a particular surface layout the complementing disposition of a particular animal is an effectivity. An effectivity is the propensity for an animal to effect or to bring about a particular action to manifest what is needed for a state of affairs to be realised. In this way an affordance is shown to be a particular kind of disposition, one whose complement is a dispositional property of an organism. So in any particular case what must be questioned is the presence of an affordance and complementarily the presence of the effectivity.

What is called a disposition and what is called its complement changes with the focus of analysis. When the focus is the environment's capability to support a given activity the affordance is the disposition and the effectivity is the complement. Conversely, when the focus is an animal's capability to perform that activity then the effectivity is the disposition and the affordance is the complement. Given that a dispositional property is not defined when there is no complement then an affordance is not defined without a complementing animal property and likewise an effectivity is not defined.

There are significant dispositions whose complements are not properties of organisms. Nest building, tool use and like activities depend on the selection of propertied things such as twigs of a certain range of magnitude and pliability that are functionally suited to other propertied things such as a particular configuration of tree branches neither of which are organisms.

The notion of effectivities allows us to unpack abilities from affordances. This explains for instance why humans can do what animals cannot do, such as build power stations, and why animals can do what humans cannot, such as build hives, and why humans themselves differ so widely in their range of abilities. With effectivities the ecological approach is able to encompass affordances both for the self and for another.

Affordances and Animals

Affordances are what the environment furnishes or provides an animal and they are measured and understood relative to the animal. Surfaces, objects, substances, and events can have affordances, and multiple affordances, for example a stick can be used to move something or to make marks, see EAVP, p. 36.

Affordances constitute part of the domain of perception for perception is part of a way of life and this is not simply what goes on inside an animal nor just the animal's movements. Animal behaviours are descriptively tied to affordances, for example an animal walks across a supporting surface. A way of life necessarily includes reference to affordances and the environment.

Different animals engage in different behaviours and these behaviours determine which affordances the animal is able to detect. Because information specifies behaviours that are afforded and because different animals have different sets of effectivities, affordances belong to animal and environment systems and nothing less. There is, therefore, a need to include the animal in the notion of information.

At its most basic the perception of affordances is perceptually primitive. The perception of edibility for example, may occur without discriminating and identifying the particular qualities of a piece of fruit. Perception of affordances need involve neither classification nor conceptualisation. From an ecological and evolutionary point of view perception of affordances is crucial and basic to animate ways of life. Survival depends on perception of affordances. With affordance perception the ecological approach resists the widespread tendency to make perception purely a matter for the intellect and for the mind where the most the environment can offer is some non-perceptual source material for the deliverances of the senses.

Affordances depend on compound features within the environment. A surface of support for example, depends upon both the rigidity of a surface and its inclination. The affordance of supportability is specified in structured light and the perceiver does not have to perceive rigidity and inclination separately and then decide after some type of intellectual process whether it would support locomotion. A perceiver may discriminate or differentiate rigidity or inclination but it is the affordance relevant to action that is primary.

Affordances exist at a level of organisation commensurate with animate ways of life. Though the structural and compositional support for an affordance may be complex it exists at a finer level of organisation. The affordance exists at a more global level and may be relatively simple in comparison to its constituent support. Consider how simple the affordance of writability is for a pencil or a pen compared to the complexity of factors that make up a pencil or a pen. First, there is no one set of complex, constituent factors that is necessary. They may be made of wood, plastic or metal, be short, fat, green, heavy and so on. Second, if we perceive the parts before the whole then at what point do we stop? Though we may analyse pencils or pens into a series of increasingly fine levels of

organisation down to atoms and sub-atomic particles this serves no perceptual purpose.

A large part of the ecological discussion of affordances is wrapped up in issues concerning tools, tool use and other animals especially other animals of the same species. Human beings are advanced tool using animals we know. Tools have affordances and reciprocally these affordances are constructed into the tools. Tools are made with affordances put in terms of uses. Through the development of tools and complex instruments the affordances of the human environment are increased and refined to suit human life. In this way the ecological approach seeks to integrate the social and technological spheres into the general theoretical framework of dynamic reciprocity, see EAVP, pp. 133 to 141.

The notions of "function" and "use" may be used to introduce the idea of affordances but the notion of "affordances" is more basic and encompassing than either. Affordances are relational properties of the environment defined relative to the ways of animate life. At times affordances are not like uses at all. We may say environmental ambience affords locomotion, surface layout affords orientation, persons afford companionship. So while the uses and functions of the environment are affordances, not all affordances are uses.

On the ecological approach it is the affordance that is perceived by the perceiver. Affordances cut at this, the level of the perceiver. An animal perceives which behaviours can be entered into with respect to the environment. On this interpretation we do not say that humans perceive chairs and doughnuts but rather that they perceive places to sit and something to eat. To say that affordances are perceived means that information specifying these affordances is available in the stimulation and can be detected by an appropriate perceptual system.

Misaffordances

Affordances were initially held to afford what they afford and nothing else. This makes the notion of misaffordances puzzling. The optic array may yield information that causes a perceiver to perceive an affordance and yet behave in an inappropriate manner. This is a case of perceiving an affordance in the usual way, behaving in a manner which respects the intimate relationship between affordance and behaviour and yet acting in an inappropriate way. On the ecological approach nothing has misled the perceiver for nothing is awry. Nothing is abnormal about the pick up of the affordance and hence there is nothing deviant about the subsequent behaviour. From this it would appear that there is no consistent notion of a misaffordance. An affordance stands as an affordance despite any consequences of subsequent behaviour.

There are cases of putative misleading affordances where we act in a way concomitant with our perception, with our perceived affordances and yet, given the circumstances, do the wrong thing. For example when I see an unstable chair I may make use of a perceived sittable-on affordance. I do not pick up perceptual information indicating the instability of the chair. I sit on the chair and the chair collapses. No sittable-on facility has been afforded. It is not clear in what sense this can be said to be a misleading affordance for the affordance perceived was the very one supposed. What I have done in my case is to underspecify my own affordance. The affordance afforded was "sittable-on if sitter is less than five kilograms", say. This would have been perceived on closer inspection of the chair. I assumed that the affordance was simply "sittable-on", and from my point of view in the environment I was unable to see difference, that is I was unable to pick up a more specific affordance. As the ecological approach predicts, the more specific affordance was perceived upon further exploration of the environment, namely the event of the chair collapsing under my weight.

Like all perceptions affordances are not propositional and hence they are neither right or wrong nor true or false. We may of course say that a perceiver's action is appropriate or inappropriate given other, non-perceptual circumstances. This is the closest the ecological approach can come to acknowledging the notion of misaffordances.

Implications of Affordances

A theory of perception cannot be satisfactory without an account of the features of the environment that perception discriminates.

Affordances present something particular which the environment affords the perceiver. To grasp an affordance is to perceive something in a particular way. It is direct, it is not inferential. It may be reacted to or ignored in a behavioural way. Once picked up an affordance may be referred to or inferred from, in a cognitive and non-perceptual way. It may for example be remembered.

There are an indefinite number of affordances for an indefinite number of perceivers. A perceiver may perceive a stretch of water which affords swimming in (recreation) for a human, living in (habitat) for a fish, feeding from (nutrition) for a gull, laying eggs in (reproduction) for a frog, and so on. Affordances are constrained by the type of organism that is perceiving though the perception of affordances is not restricted to the perceivers that may make use of them.

The environment of an observer consists of the affordances of objects, places and events for that observer. Affordances are the functional properties of objects as for example, the affordance of a

heavy stick or rock for pounding. Any particular object may have many affordances. An apple may be eaten, thrown, juiced, baked, or given to teacher to name a few of its affordances. Yet a given object will lack many affordances. An apple will not afford building, kindling, or writing.

In describing the nature of affordances Gibson says,

"The affordance of something does not change as the need of the observer changes. The observer may or may not perceive or attend to the affordance, according to his needs, by the affordance, being invariant, is always there to be perceived. An affordance is not bestowed upon an object by a need of an observer and his act of perceiving it. The object offers what it does because it is the object it is. To be sure, we define *what it is* in terms of ecological physics, and it therefore possesses meaning and value to begin with."

- EAVP, pp. 138 to 139.

Here Gibson is making an explicit claim as to what the nature of the world is independently of our participation in it. The independence of the environment, irrespective of the perceiver, is crucial to the whole ecological approach to perception and mind. In particular the ecological approach makes explicit the relational character between the environment for an activity and an organism engaging in that activity.

In this way affordances exist in an environment whether anyone perceives or attends to them or not. A pragmatic view would say that an affordance is only completely specified as the affordance it is when the activity it affords is complete. Though it may seem that affordances are there in the environment irrespective of whether anyone is there in the environment to perceive them or not, this can only be so in theory. The idea that something is possible only in theory goes against Gibson's demand for ecological realism, see EAVP, p. 238. We must therefore say that, prior to the performance of some further activity within it, the only clear and accurate description of the affordances of an environment which can truly be given is one in terms of the actions so far taken within that environment. We may however, all things being equal, consider types of environment rather than simply individual instances of environment.

Even where certain actions have been taken in an environment what further action it may afford remains to a large degree uncertain. There remains, however, the possibility of intelligent selectivity in the performance of any future action made on the basis of current awareness. The ecological approach is thus able to remove the need to refer to any mental activities mediating the relation between perception and action. The theory of ecological direct perception, as

set out below, explains perception without reference to mental acts such as recognition, interpretation, inference, and so on.

The affordances an object may or may not afford is related to the meanings that object may have for the organisms that may exist in the environment of that object. For instance, the meanings of the positions of artefacts and objects shed light on the affordances of those objects. The positions of artefacts and objects as social roles in a social organisation or activity can be considered to be a social affordance. In this way the ecological approach is shown to have application and importance far beyond the narrow study of perception embracing investigation of the mind and all that is physical, biological and mental, in particular all that is human.

On the ecological approach one does not perceive an object without also perceiving oneself such that perception is a unitary act of awareness of a specific relationship between the self and the environment. If an object is knee high, fairly resistant to deformation with a sufficiently large and relatively flat surface then it affords sitting. These properties of the environment are taken with respect to an animal. For instance, knee high specifies something quite different to a toddler than to an adult or to a mouse. A single object may yield different affordances to different perceivers not because affordances are subjective but because they are functional, related to the observer as well as to the environment. As Gibson put it,

"An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacies. It is equally a fact of the environment and a fact of behaviour. It is both physical and psychological, yet neither."

- EAVP, p. 129.

For example a chair affords sitting even when one wishes to stand thus demonstrating the fact that an affordance is an offer or offering, not a requirement nor a cause. This and other ideas expressed in this section are debated by Endre Kadar and Judith Effken in their "Heideggerian Meditations on an Alternative Ontology for Ecological Psychology", *Ecological Psychology*, 6, 1994.

Affordances are relative to the species of animal. In general there are certain fundamental affordances that exist for all members of a basic form of life. The environment affords space for life. The ecological selection of the spatio-temporal scale for a structural description of the environment is determined by the spatio-temporal scale of animal life and by how the functions of the environment are tied to the ways of animal life. In this way the concept of affordances moves towards resolving mind-matter dualism by connecting ecological structure (space) with ecological changes (time) and by connecting meaningful matter with the ways of life of animals.

Ecological functions in dynamic actualisation are tied together with affordances in ecological events involving animals and the environment. In turn the environment is tied to the animal through the affordances that the environment offers the animal. In this relation the animal-environment distinction is necessarily reciprocal due to the dynamic features of the relationship.

There is an ecological relationship between affordances and meanings. Meaning is not added to raw sensations nor is it given to the world of physical stimuli. Meaning is part of the ecological environment as affordances are part of the environment. Meaning is revealed in the environment through change and over time as affordances are specified in the invariants of transformations. Perception of affordances is tied to the perception of events. The child perceives affordances and proprioceives capabilities by participation within ecological events. In this way more sophisticated cases of perception may be accounted for in terms of affordances, see J.J. Gibson, "The Construction of Meaning Versus the Detection of Meaning", *Purple Peril*, 1968.

The ecological approach holds that any correct understanding of perception requires study of both perceiver and environment. As Berkeley famously points out, tilting a circular coin away from us produces a projected elliptical shape. Mathematics shows the ellipse to be a transformation of the circle. Ecologically there is an invariant in the property of the shape that affords the perceiver the information that a tilted circle is in view. Our sensitivity to this transformational invariant is the basis of our perception of shape constancy. This explains the particular perceptual phenomenon in terms of an ecological theory. Investigation of the actual transformational invariant is an empirical question open to investigation by ecological psychology. Thus both the construction of ecological theory and empirical investigation draw on the philosophy of the ecological approach.

Chapter Three : Ecology and Environment

The starting point of the ecological approach is an ecological description of the environment. Gibson identifies the environment as what is perceived. It is ecological because it is understood relative to animals, see SCPS, p. 7.

The term "environment" means a surrounding so that whatever is in the environment such as a perceiving organism is surrounded. The concept of the environment is explicitly ecological. Animate life is understood in terms of distinctive ways of life namely perception and behaviour. The ideas of surround and of ambience are tied to animate ways of life. The environment is that special type of surround in which animate life exists. The ecological approach explores how the surroundings afford perception and behaviour and how the structural and dynamic conditions are satisfied by it.

The environment has been analysed in many different ways. In physical science it is broken down into matter, energy, and the interaction of elementary particles. With respect to ecological relationships there are substances, media, surfaces and surface layouts. These may be described with opaque solid geometry. Introducing light and ecological optics bring in the structural ecology of energy and matter. Once the ecosystem is set in motion so affordances become available. Psychological and epistemic development begins with perception of affordances and culminates in the abstractions of theoretical physics. In this way time and function are shown to be at the base of perception, see J.J. Gibson, "The Affordances of the Environment", 1972, in RFR.

The explanation of perception involves an understanding of how stimulation from the environment can specify the environment. This, the ontology of the perceptual environment, is a key part of any perceptual theory, see for example A. Ben-Ze'ev, *The Perceptual System*, 1993, pp. 89 to 101. According to the ecological approach the ecology of the environment is objective and is not based on any absolute dualism. Dualism ascribes the intelligibility of the world to the mind. The ecological approach shifts the emphasis over to the environment. The explanation of our knowledge of the external world is ecological. It involves both perceiver and environment.

The ecological approach conceives of the environment as those conditions in which life has evolved. In considering the evolving structures and capabilities of living forms, it is the ways of life and opportunities of the environment that serve as the framework for an ecological account.

Having a way of life involves affordances of the environment and life has evolved in a variety of ways to take advantage of what the environment has to offer. An ecological compatibility has evolved between life and the environment. This compatibility is shown in how inextricably and essentially the environment is involved in the ways of life of the perceiver. There is therefore an important reciprocal relationship between affordances and animate ways of life. The environment in general may be described in terms of meaningful affordances that are functionally related to the capacities of animals. It is within this global level of ecological organisation that all the basic features of perception are nested, see J.J. Gibson, "Ecological Physics, Magic

and Reality", 1979, in RFR.

The environment has many levels of structure with smaller units embedded in larger units. There is a spatial and a temporal nesting, for example the day-night cycle is embedded in the seasonal cycle. Ecology relates to this description of the environment insofar as it deals with the levels of structure relevant to life or to the form of life in question. Due to its physical make up the environment determines the structure of stimulation and the medium affords its transmission. Information about the environment is specified in the medium in this way.

The ecological approach is not a teleological analysis of perceivers in environments. It is a mistake to attribute a teleological interpretation to the ecological description of the environment as if the environment was created to furnish animate life with what it needed to exist. Animate life is evolving and changing and the necessary conditions for its existence in numerous respects could not, in principle, be anticipated. The environment had a potential existence prior to life filling its niches that are its opportunities for existence. The harmony between environment and animate life is due to the latter developing abilities which use those opportunities potential in the former. Animals create new opportunities by their very presence. Many significant features of our environment have been constructed by us and much of our environment involves the presence and effects of other living forms, see EAVP, pp. 8 to 10.

With the ecological approach it is possible to show that the physical features and properties of substances are completely specified within the invariant patterns of energetic structural modulation through the environment. Part of the structure of the array of ambient light specifies the observer. The limits of the array are bounded by the observer's body and head for the eyes are not out in front of us hence at all times of human visual activity the observing self is contained in the field of view so that self-perception and environment perception go together.

The co-perception of environment and self allows the simultaneous pick up of information about one's destination and its imminence and about oneself in imminent contact with it. This for instance accounts for why, though we shrink back to some extent in a cinema when a film depicting imminent contact is shown, we nonetheless remain in our seats. We do so because the limit of the field of view is not ourselves but the edge of the screen. On the same principle a flight simulator, in completely filling the field of view, can make a perceiver airsick.

The ecological approach centres on aspects of the world of lived experience and attempts to derive a description of that world as experienced which in turn allows an account of how we perceive what we do the way we do. A description of the world for an experiencing organism is constrained by the sort of organism for which the world is an environment. The inclusion of the environment and the factors that follow from this inclusion is necessary for an account of perception. What constitutes an environment thus varies according

to the kind of experiencing organism, whether mammal, reptile, bird, or fish, whose world we set out to describe. The account is of organisms that experience the environment in virtue of systems sensitive to patterns of energy. Thus three fundamental properties can be delineated as medium, substance, and surface.

A more or less homogeneous medium like air or water allows the propagation of electromagnetic, mechanical and chemical energy in ways governed by the medium's own physical and chemical composition. A substance like the ground is relatively heterogeneous and differentially affects the propagation of energy, reflecting and absorbing it according to its physical and chemical properties and along with these the layout of its surface.

By definition all substances in a medium have surfaces though some substances such as smoke are continually nascent and evanescent. Electromagnetic energy is affected by the layout of the surface of a substance and by its composition. So what humans designate as a large round grey rock affects the propagation and reflection of electromagnetic energy differently from what they term a small square red brick.

A proportion of reflected electromagnetic energy from the surfaces of the world and the particles of an aerial medium becomes describable as ambient light when it fills a medium that is part of habitable world of an organism sensitive to the patterning or optical structure of such reflected energy.

Visual perception is the pick up of information specifying environmental features within a continuous, flowing, optical structure by organisms which move across, around and under the surfaces of substances of their environments. A useful distinction may be made here between the *modus vivendi* (way of life) and *modus operandi* (way of operating). The character of the sample is given by the *modus vivendi* and the *modus operandi* of the organism. The notion of affordance accounts for how this *modus vivendi* relates to the *modus operandi*. As the notion of information pick up tells us what perception is and the notion of affordance tells us how the perceiver relates to the perceptual environment.

Ambience in the Ecological Approach

Ambience is the context or setting of the animal in their environment. It relates to the animal, the environment and the whole situation in which perception and life takes place.

The environment is objective or intersubjective in virtue of its ambience. An animal is able to move about and occupy different positions within the surround. Different animals are able to occupy identical positions over time. An animal, unlike a plant, is not fixed to one position and perspective. Animals can exchange positions or perspectives. There exists one ambience for all animals in virtue of their mobility. Ambience has a different quality for animals than for immobile objects because over time animals share the same surroundings. The objectivity of the surroundings is due to the mobility of

animals realised over time. This shared, engulfing permanence delivers ecological objectivity though this can only be defined by assuming animate life. Ambience, though the ground of objectivity, pertains to a relational or ecological property with respect to mobile perceivers.

Ambience designates the ecological fact that the environment surrounds animals. The environment is tied to the animal by this concept before any animals. The environment is tied to the animal with this concept before any discussion of what is perceived or how the environment is the source of stimulation. Animate life is to be understood as existing within an ecological context. The subject matter of perception and mind is not of a separate realm independent of the world.

Ambient life is a consequence of an ambient ecology and the dynamic structure in light is a consequence of the dynamic structure of the ecology. Perceptual information is present due to the unique relationship between the structure of the ambient environment and the perceiver. As the information is ecological, this structure possesses concurrent specification of both the perceiver and the environment. In this way ecological ambience implies a reciprocity of something surrounded and something surrounding related in terms of this ecological information.

Gibson elaborated the theme of ambient structure stressing that the ambient optic array is the central concept in ecological optics. He rejects analysis in terms of the observation point which is held to be an unnaturalistic geometrical fiction, see EAVP, pp. 65 to 76.

In the ecological approach there are positions and paths localised within the ambient environment. Solid angles rather than rays make up the structure of the optic array because angles have form whereas rays do not. Natural perspective has limitations for it geometrises the world and so omits both motion and time (as they are dynamic). Optical structure cannot be considered simply to be a projection for optical structure contains information for occluded surfaces. The dynamic flow of the array cannot be construed in terms of motions. Better descriptive terms would be disturbances or disruptions.

Persistence and Change

Two of the most important ecological terms are "persistence" and "change". The environment we live in and experience does not disappear when we close our eyes, turn our heads, or walk away. The objects, events, and places surrounding us tend to persist, some for greater amounts of time, others for lesser. This is the ecological notion of persistence.

In ecology the notion of change runs on the fact that resources are scarce. Once the resource is used up it is gone. Organisms are able to use resources and so these resources may become exhausted or extinct. In the environment objects can and do go out of existence. Resources which make up the environment disappear without being conserved. When an apple falls a

physicist is indeed able to show how its matter and energy are conserved but when an apple is eaten by a satisfied animal an ecologist is able to show that the apple has not persisted across the transformation of eating.

"When a solid substance with a constant shape melts, as a block of ice melts, we say that the object has ceased to exist. ... Ecology calls this *non-persistence*, a destruction of the object, whereas the physicist calls it a mere *change of state*. Both assertions are correct, but the former is more relevant to the behaviour of animals. ... Even if terrestrial matter cannot be annihilated, a resistant, light reflecting surface can and this is what counts for perception."

- EAVP, pp. 13 to 14.

The ecological approach distinguishes three kinds of persistence and change,

- a) Environmentally produced,
- b) Animal produced,
- c) Products of functions of animal-environment relationships.

Persistence and change are reciprocals. They partake in reciprocal relationships. Persistence and change occur and recur in response to each other.

The layout of a particular place in the environment is permanent but its features may exhibit changes. Some of the changes are short term such as seasonal variation in vegetation, others are long term such as erosion, subsidence and elevation. Among the most important persistences in our environment are the existence of a medium, air or water. They allow locomotion, respiration and the formation of arrays carrying information that support perception. Without such long term persistences life could not have evolved.

Information about persistence is not the persistence of stimulation, and the perception of persistence is not based on the persistence of sensations. By careful distinction between external objects, physical optical information, ecological optical information and perceived phenomena (perceptions) the ecological approach is able to break the hold of sensationalism. The information for something must specify it but in no way need resemble it. We do not see our retinal images nor our cortical images. What is necessary is that information specifying the persisting environment is available for pick up by the perceptual systems and in particular by the visual system. This optical information distinguishes going-out-of-sight from going-out-of-existence in a way that is contrary to the atomistic theory of persistence.

Change is a significant feature in the description of the ecological environment and the ecosystem of a moving observer. The ecological approach relates change to order and constancy and does not treat them dualistically. The ecological approach relates persistence to change in a dynamic,

environmental way.

The ecological approach holds that everything changes in some respects but not in all respects at the same time. In some respects change is only possible because of persistence in other respects and that whatever is invariant or persistent is so relative to some specific group of transformations. These are known as ecological persistence-change pairings.

Our awareness of objects, events and places is not the flickering flux of sense impressions but the perception of the persistence and change of the things around us. What is seen is not what is seen from here at this moment but is what can be seen by an active observer. A surface that is hiding another surface is perceived differently from one that is not occluding anything. A full soup bowl affords far more temptation to the hungry perceiver than an empty one. A solid surface that is approaching affords avoidance whereas a solid contour such as a large aperture or window that is approaching affords exploration of what can be seen and found through it. The facts of environmental persistence and change are at least as real as facts of physics concerning atoms, entropy, and conservation. We see our environment, not the world of physics.

Object Identity and Permanency

The ecological description and explanation of the perception of object identity and of object permanency enables us to answer questions such as; Why is a physical object seen as the same object over time even when it changes position ? Also, how is one object distinguished from another object ? The ecological approach deals with such issues under a general account of the permanency of the perceived environment.

The invariants for a set of ecological transformations for one object are distinct from the invariants for another object. A projection of an object is related to the projection of another object by a discontinuous transformation whereas any two projections of an object are related by a continuous transformation. In accounting for the visual perception of object identity the concepts of invariance and transformation are fundamental.

Visual perception of the continuance and permanence of the environment depends on the invariants of transformations of a sampled series of optic arrays. By virtue of the fact that these invariants exist across optic arrays, optic arrays are united and not discrete. As the observer moves from place to new vistas of the total environment open up and some existing vistas disappear. The characteristics of the environment that are in view change. This implies that there is a continuous change of optical invariants as the observer moves from place to place. There can never be a complete change of invariants between any two connected series of arrays hence all the arrays of the medium of the total environment are related to one another and the environment is perceived as

continuous. In this way continuity of perception is guaranteed across changes in ecological ambience.

Surfaces in the Ecological Approach

Surfaces play a key role in human perception. Surface perception is the perception of surfaces of any of those ecological constituents that have surfaces. Surfaces are complex features.

The environment contains substantial surfaces which persist for varying durations from evanescent clouds to solid cliffs. The changes in shape, position, substance or other qualities of these substantial surfaces are what count as ecological events. These changes may be listed as follows,

- 1) Changes of layout due to mechanical forces, such as falling, flowing, and animate movement,
- 2) Changes of colour and texture due to changes of composition, such as skin colour change with the ripening of fruit, and,
- 3) Waxing and waning of surfaces due to changes in the state of matter, such as decay, melting and dissolving.

When a group of substantial surfaces forms a topologically discrete entity, that is one that undergoes its own characteristic change, it is an object with at least some minimal persistence. Smoke and clouds may be too evanescent to be discernible objects and so are events or disturbances in the medium but a snowflake may persist and persist long enough to be considered an object as may a rock, a plant or an animal.

Gibson's notion of surfaces parallels that of Martin Lean and Roderick Chisholm. All three hold that in seeing surfaces a perceiver is directly seeing the objects that have those surfaces. Gibson however developed his own unique conception of surfaces within an ecological perceptual environment, see M. Lean, *Sense Perception and Matter*, 1953, and R. Chisholm, *Perceiving*, 1957.

Gibson's view also shares certain similarities with G.E. Moore's common sense approach to perception. Both Gibson and Moore argue that we see surfaces directly. Gibson concludes that we thereby see objects directly whereas Moore does not. Gibson argues that surfaces saturate the visual field. They are everywhere. When we see anything that has a shape, that is a position relative to other observables, and that has some sort of outside texture we see a surface or some surfaces. Surfaces play pervasive and encompassing roles in perception, see G.E. Moore, *Philosophical Studies*, 1922.

The attempt to construct a coherent theory about the perception of surfaces presents several difficulties. There is the problem of what is to count as a perceptual object. There are difficulties of an empirical sort faced by all perceptual theories such as the explanation how the theory can do justice to the complexity of the empirical facts that are to be accommodated. These are empirical difficulties that all theories of surfaces must face for the data to be accommodated are numerous and complicated. One particular difficulty concerns the relationship between macroscopic and microscopic surfaces. There is no general theory that fully explains this relationship though in the ecological approach ecological theory goes hand in hand with ecological empirical research.

Surfaces have been defined as the interface of substances and the medium. Surfaces contain information about substances. Though surfaces are clearly relational the term "substance" connotes something intrinsic and independent of possible relationships with other substances. The ecological approach ties ecological substances to both surfaces and to affordances. This ensures they do not have a purely intrinsic characterisation.

Due to their texture and pigmentation surfaces reveal the composition of substances. Substances have other properties such as hardness, viscosity and density. Such properties when related to the capacities of animals constitute the affordances of substances. On the ecological approach when an animal perceives a substance it is able to perceive the various affordances of the substance. A surface is not a veil of appearance covering the inner reality of a substance but rather it is the interface of a substance with a transparent medium. A surface reveals a substance, see EAVP, pp. 19 to 21.

The layout of surfaces provides the spatial structure of the environment. Another major feature of the environment is the medium such as air for land animals or water for aquatic life. Animals move across surfaces through the medium. The medium affords locomotion. The surface layout and the medium support behaviour. Information about the environment is broadcast throughout the medium. Because the medium is transparent it permits the flow of information.

Perspective in the Ecological Approach

Central to the ecological approach is the notion that perception is an activity thus what is perceived is in no way analogous to a static image or form. Though an observer can view an object from a variety of perspectives it is the invariants over time that determine the perception and these invariants are not static forms. When an observer moves it is the whole rather than the perspective that is

noticed. This whole is reciprocal with the observer related perspectives.

The ecological approach accounts for perspective in terms of the concept of perspective structure. This is based on the point of view of perspective geometry. Having a point of view is neither a physical nor a mental construct but an ecological fact. From a given single point of view any perceptual layout produces a unique optic array with some parts hidden by others and with particular perspectives of each unhidden face visible. These occlusion relationships and perspective forms change with any movement of the point of view. The changes that occur as a result of locomotion constitute the perspective structure of the optic array. The basic kind of change is motion perspective which specifies the path of locomotion.

Perspective structure is a particular kind of optic flow with unique patterns of accretion and deletion of optical texture, and unique patterns of deformation of the projected solid angles of surfaces. Perspective structure specifies a path and not a point of view. Locomotion opens up hidden aspects of a layout.

Perspective structure in the optic array specifies the environment of one observer, that is what a single individual would encounter along their path through the world. Invariant structure in the array specifies the environment of all observers, that is what an observer would see on any path in the ambient environment. What is specified in both cases is an animal and environment relationship. Just as the relationship between the environment and the animals within it is one of mutuality so all forms of optical information specify the self independently of the environment. The invariant structure specifies things independently of the self. Everyday vision is a mixture of proprioception and exteroception. Perspective structures specify where the perceiver is heading and invariant structures specify the nature of what the perceiver is heading toward.

It is common for philosophical views of perception to equate perspective structure with a static viewpoint or with a static picture. This view is ecologically incorrect. The ecological approach requires the treatment of all forms of stasis as limits of flow. A stasis is a special case of flow. A static picture of a table, for example, collapses the perspective and invariant structure. A stationary, monocular observer or the observer of a picture has difficulty separating the information specifying their environment from that specifying the environment of all observers. The changing perspectives are unavailable in the static case as are the alterations of occlusion. This is why it can be difficult to see both the shape of things in a picture and the connectedness or lack thereof of all the surfaces in a picture. Perspective does not add depth to flat surfaces nor does it provide an illusion of realism, see EAVP, p. 87.

Gibson considered that the question of how a rectangular surface like a table top can be given to sight when presumably all that an eye can see are a large number of forms that are trapezoids, to be the wrong question. What should be asked is what the invariants underlying the transforming perspectives in the array from the table top are. The trapezoidal forms do not feature in the account for it is their transformation that counts as the perspective structure and the invariant structure is revealed by these transformations. He says,

"Although the changing angles and proportions of the set of trapezoidal projections are a fact, the unchanging relations among the four angles [such as cross-ratios] and the invariant proportions over the set are another fact, equally important, and they uniquely specify the rectangular surface."

- EAVP, p. 74.

The ecological approach perspective helps a perceiver to see from a single point of view for,

"If a picture displays the perspective of a scene it puts the viewer into the scene, but that is all. It does not enhance the reality of the scene. What is induced in these pictures is not an illusion of reality but an awareness of being in the world. This is no illusion."

- EAVP, p. 282 to 284.

Perspective requires seeing from a single point, the point of perspective. This is not normal seeing, that is seeing from a path and not from a point. Motion pictures can begin to provide some of the information for seeing the world from a path such as that which suggests an observer approaching an object. What is most important in motion pictures is not the availability of perspective structure but the display of invariant structure which depicts the environment of all observers through such devices as multiple points of view, glimpses of the surroundings of a scene and so on. This work has been taken up and extended to different areas by others including Margaret Hagen.

Occlusion in the Ecological Approach

Occlusion may be found in any cluttered environment populated with localised perceivers. Reversible occlusion occurs due to reversible locomotion and looking behaviour. These facts provide us with an ecological explanation of the spatial connectivity of the environment. When one object moves behind another with respect to the line of sight to a given station point, the microtexture and the surface features of the occluded object are progressively deleted from the array. They vanish precisely at the edge between the two solid angles that the objects subtend. If an object emerges from behind

another that is disoccluded then such elements are accreted rather than deleted. The microtexture of the occluding object, however, undergoes neither accretion nor deletion. In this way the ecological vista of the environment is seen to be reciprocal with the perceiver's field of view. Vistas are spatially connected through reversible occlusions. Animals perceive environmental connectivity rather than associating responses to stimuli or constructing internal maps of the terrain. Thus the ecological approach supplies a working alternative to both stimulus-response and cognitive map theories of orientation and oriented locomotion.

Further to the above points, according to the ecological approach mental images are neither necessary for thought nor necessary for perception. Perception of occlusion demonstrates this ecological fact. With an occlusion there is a perception of something in the environment yet there is no qualitative content of what is occluded for what is occluded cannot form an image. What is perceived is the occluded object in its entirety. This is clear for affordances where the perception is of ecological meanings which are neither image like nor object like.

Though there are relative invariants for a layout that underlie all possible perspectives and reversible occlusions these invariants are defined as reciprocal to the variants of stationary and moving observation. The possibility of public or objective knowledge depends on discriminating the ecological invariants existing within the ecosystem of an ambient layout and moving animals.

The terms "appearance" and "disappearance" are ambiguous in any theory of perception until going out of sight can be distinguished from going out of existence. Once this is done the puzzle about our awareness of things not present to our senses can be resolved. Such awareness may then be accounted for in terms of the study of perceptual occlusion.

On the ecological approach an object may come to be perceived as permanent even when it is partially or entirely hidden by another object. If a screen is drawn in front of an object so that it is gradually concealed and then gradually revealed again an infant soon learns that it has not gone out of existence and expects its reappearance. There is optical information for its continued existence and for its only having gone out of sight.

Unlike the ecological point of view, many previous studies of vision failed to distinguish optical from retinal contours. This explains why such non-ecological students of vision are puzzled about how contour, which is supposedly detected at a very low level of visual processing, is able to profoundly reorganise every aspect of the visual world. The fundamental point is that a locus of occlusion is seen for what it is. It is not perceived as a line or a margin or a

border or a contour or the mere junction of two flat surfaces at a dihedral angle. It is seen to be the place where one surface covers another. It is not just that there is depth at the edge but that a surface continues behind the edge. It is not just that the contour is one sided but that something is hidden at that place. This is a fact, not a construction of the mind, see J.J. Gibson, "The Perceiving of Hidden Surfaces", in P. Machamer and R. Turnbull (editors), *Studies in Perception*, 1978, p. 426 to 427.

Environmental surfaces are usually opaque so if an observation point is introduced the fact of occlusion emerges. Angled and curved edges occlude what is behind them relative to observation points. The front of an object will occlude its backside and objects will occlude other objects or surfaces behind them. It is because of the perception of occlusion that the environment can be perceived as spatially coherent and temporally co-existent. The ecological approach contends that reversible optic transformations constitute information for continuity of existence. Reversible transformations are produced by moving the head or the body back and forth bringing the environmental features into view and then out of view. This lawful and dynamic feature of the perception of occlusion points to a significant element in the ecological theory of space perception.

The ecological approach to occlusion ties together the spatial and temporal dimensions of perception. Continuity of layout entails continuity of existence, and both are perceived with a moving observer. The invariants specific to the connectivity of environmental layout are revealed through change. More fundamentally, the spatial and temporal features of the environment are not perceived as two sets of facts. They both derive from optical transformations produced by spatial arrangements. Ecological movement is the starting point for space and time perception, see J.J. Gibson, "An Outline of Experiments on the Direct Perception of Surface Layout", *Purple Peril*, 1968.

For a moving observer occlusion is an ecological event. The event involves a transforming spatial relationship with respect to a moving observer. Though spatial relationships relative to the observer change the temporal invariance or permanence of occluded environmental features is perceived. Through the ecological study of perceptual occlusion we are able to connect the perception of superposition, a spatial relationship, with the permanence of objects, a temporal fact.

Temporal considerations are integrated into the ecological treatment of the perception of occlusion, the spatial framework and environmental objects. Optical accretion and deletion and the general phenomena of reversible occlusion, as regularities of certain types of change, are ecological events. Reversible occlusion ties together the spatial principle of ecological co-existence with the

temporal principle of ecological concurrence. Reversible occlusion takes time and the perception of persistence of surfaces being hidden and uncovered indicates perception extends in to the future and the past.

Ecological occlusion also relates to the problem of depth perception for seeing one thing behind another involves seeing distance or depth. Increasing distance is seen at the edges of surfaces.

In criticising sensation based theories of depth perception Gibson argues that perception of occlusion implies seeing more than one thing in a given direction. A sensation based theory of perception would imply that only one thing can be seen in any direction. Sensations would so form a two dimensional configuration. Gibson does not deny that occluding edges can be perceived when the observer is stationary but points out that the information in this case is impoverished. The natural condition for animals is movement and under such conditions occluding edges are specified often unambiguously, see J.J. Gibson "The Perception of a Permanent World", Purple Peril, 1969.

Now, the vistas of the environment are connected and there exists a permanency to the world. As an animal moves about new features open up from behind edges and other features become occluded, going out of view. What appears does not seem to come into existence or rather into view and what disappears does not seem to go out of existence or rather only out of view behind an edge. Objects and surfaces are perceived to continue behind an occluding edge and when completely hidden from view they are, nonetheless, perceived as still existing there. This then is an example of perception without sensation.

Four: Information and Pick Up

We may analyse animals in terms of their place in nature, their peculiar anatomical features, their means of communication and also in terms of their receiving information.

Many non-ecological approaches to perception and the mind, especially those standard accounts (such as Cornsweet's) popular with psychology undergraduates, hold that the brain receives information of two varieties, that of the receiver and that of the ambient surroundings. Some of this information reaches consciousness and some is held to reach some as yet unspecified lower centres, see T. Cornsweet, *Visual Perception*, 1970.

According to this non-ecological approach there are three anatomical entities necessary for the information received to be so appreciated. These are,

- a) Some form of receptor capable of responding to stimuli,
- b) Some form of proprioceptive sense-organs in tendons and muscles to contribute to the provision of information about orientation of the body in space, and,
- c) Some form of conducting pathways of nerve fibres leading from the sense-organs to convey nerve impulses initiated by their stimulation. These must reach some region of the nervous system that possesses a perceptive function one that is capable of receiving the information from the sense organs. Such a region could be the sense organ itself such as the brain.

The ecological approach rejects all such accounts. The disagreement is not about anatomy or neurology but focuses on the description of perception and the existence of any lower centres of perception or their equivalents.

Such theories do not make use of ecological perceptual information. Ecological perceptual information is structure that specifies an environment to an animal. It is carried by higher order patterns of stimulation that are complex structures given over time. There is no role for either points of light or collections of such points. There is no role for images. These patterns constitute information about the world.

It must be emphasised that, in particular, ecological information is not the same concept as employed in information theories of psychology where the major concern is the functioning of signal systems for it cannot be used to argue that perception is the reception of signals from the world interpreted by the brain. On the ecological approach the receptors and the brain are systems for the

obtaining of information through the relation of the animal to its environment. This is a constantly changing relation which is part of the process of information pick up. This relation is described as detecting invariants of one sort or another. They are in part responsible for pick up of affordances and grasp of perceptual content. They represent some feature which constitutes some part of the optic flow.

The account of how information is picked up is part of the general theory of ecological optics. Ecological optics itself makes no reference to aspects of experience. It has points of observation for which there are invariant structures in the changing optic array. This concerns all the light relevant to the eye and can be employed without reference to perceptual experience. It assumes that the sense organs are ecologically adapted (by evolution) to the perceptual system and that they function in this way by dint of evolution within nature. Perception is not simply a system for obtaining visual information about the world.

Information about the world comes from the world. This information is not given innately. Constructivists too agree that an animal is constantly interacting with its environment, taking in information, doing something and picking up fresh information from the environment from what it has done. The task of ecological theory is to determine the nature of the information being received and to show that this is done by information pick up in a reciprocal and resonant way.

Ecological information specifies the affordances of things. It does not specify abstract physical properties but rather yields ecologically relevant properties such as texture, resistance to deformation and manipulability. Both kinds of properties may be real but it is the functional properties, the affordances, that animals are directly aware of.

One of Gibson's major achievements is the theory of how information can specify such affordances. Sensation based approaches attempt to discover which sensations correlate with which physical properties of the environment. The ecological approach determines which information specifies the affordances of the environment for behaviour and so links perception directly to the functional properties of the environment.

Ecological information refers to the specification of the perceiver's environment. It does not refer to the specification of the observer's receptors or sense organs. What ecological information specifies is the qualities of objects, in contrast to the qualities of the receptors and nerves which are specified by sensations. Ecological information about the world cuts across the qualities of sense.

The ecological approach does not use the term "information" with the meaning of knowledge communicated to a receiver. Information pick up is not a case of communication. Ecological information persists in ambient light, sounds, touches, odours and tastes. This information is inexhaustible. There is no threshold for information comparable to the stimulus threshold of traditional accounts. To hold that information stimuli are imposed on a passive subject is to have the wrong picture, for the living organism obtains stimulation precisely in order to extract the information. This means that the same information can be obtained from radically different stimulations. In this way ecological perceptual information admits the possibility of illusions. It is in this way too that ecological perception may account for misaffordances.

The ecological study of perception is the study of an animal-environment ecosystem. Information is the glue that holds the system together. It maintains the contact between animal and environment. Thus information is to be understood with respect both to the animal-environment relationship that it specifies and to the environment and the animal with whom that relationship is specified. The unitary nature of animal and environment taken together with the interweaving of perceiving and acting leads to the claim that animals are born to detect and to learn to detect the affordances of their environments.

The nature of perceiving is flexible and opportunistic for,

"the information registered about objects and events becomes only what is needed, not all that could be obtained ... only the information required to identify a thing economically tends to be picked up ... "

- SCPS, p. 286.

A property of proximal structure such as an optic array property can constitute perceptually useful information if it varies monotonically with variation in a relevant distal (distant or widely spaced) property and at the same time remains invariant under the circumstantial variations, namely the transformations, that occur. Properties that exhibit this kind of invariance are referred to as invariants in a perceptual theory. The availability of informative invariants depends on the lawfulness and regularity of the events of the ecological system. The informative value of a particular proximal (near and immediate) property is contingent on the prevalence of a set of constraints such that the transformations that can actually occur are limited to those that are benign to the property. Such constraints are the necessary grantors of information, see R. Shaw and J. Pittenger, "Perceiving Change", in H. Pick and E. Saltzman (editors), *Modes of Perceiving and Processing Information*, 1978, pp. 187 to 204.

Information in the ecological approach is a dual concept whose components are information-about as information connected to invariants, and information-for as information connected to affordances.

Much of the notion of information-about is expressed by the concept of invariant. From a psychological point of view invariants are those higher-order patterns of stimulation that underlie perceptual constancies or more generally the persistent properties of the environment that an animal is said to know. From the perspective of ecological physics invariants come from the lawful relation between objects, places and events in the environment, part of which is other animals, and the structure or manner of change of patterns of light, sound, skin deformation, joint configuration and the like.

Perceptual information does not come to us through perceptual processing. Perceptual information comes to us through the perceptual environment. Processing is not the sort of thing that is in itself informational nor does it carry information. Processing processes information. Though there are perceptual processes, perception is not processing. Perception is pick up of information.

What is picked up from the optic flow is perceptual information. Perceptual information does not consist of stimuli nor of patterns of stimuli. A receptor responds to stimuli not a perceptual system. A perceptual system extracts perceptual invariants from the environment. The extraction of invariants alone is not perception. Though the extraction of invariants may be described as a process and the operation of a perceptual system may be described in terms of processing neither of these points implies that perception itself involves a process or may be described as processing, no more than driving may be described as a process relating to the processing of mechanical forces produced by the extraction of energy from the controlled combustion of hydrocarbons.

According to the ecological approach an organism's capabilities for perceiving and the environment within which these functions occur are co-implicative. Neither animal nor environment can be considered independent of the other. The environment an animal perceives, its ecological niche, is a subset of the potential informational structure that is available. It is perceived by the animal because of the specific structure of the perceiving functions of the animal. Conversely the structure of the perceiving functions is what it is because the animal has evolved with respect to particular informational structures that constitutes the ecological niche of that species. The relationship between the animal and the environment is necessarily co-implicative when the evolutionary perspective is taken seriously. With this view any discussion of the environment or the animal is relational and implicates its counterpart.

Information offers more than a description of the environment. Information specifies an object or event and as such is structure in the ambient array that a particular animal is sensitive to. To describe the informational structure of the environment is to provide simultaneously a description of the perceiving sensitivities of the animal. Information points both to the structure in the ambient array and to the structure of the perceiving functions of the animal.

One objection to this is that an ecological description of informational structure while reflecting some aspects of the perceptual capabilities of the animal is not an account of what is going on in the animal. What then is going on in the perceiving animal ? There are two kinds of way to answer to this question,

1) Make reference to physiological data and models.

This is a reductionistic answer which must be kept distinct from molar analyses of the environment and animal functions. A physiological explanation of perception is commensurate with a physical description of the environment but commensurate with the type of molar (pertaining to wholes rather than parts) analysis that Gibson offers.

2) Provide cognitive models of hypothesised mental functions.

Postulation of cognitive models distinct from the environment is dualistic for it implies a discrete separation of animal and environment. As such it is not in accord with the ecological approach.

For Gibson there is no need to postulate schema or concepts in the animal to account for the functional character of perception because this character is inherent in the fit between the animal and its ecological niche. The conceptual relations among objects and events with which the animal interacts are not artefacts of the animal's perceptual structures but, rather, coalesce with them.

Concomitantly, the perception of objects of particular types, A, B, and C say, does not require any conceptual structures between organisms corresponding to those classes but only that the objects stand in functional relationship with the animal. These relationships are the class designations. They are what the animal perceives.

Information and the Self

Ecological information is both exterospecific and propriospecific. It is about the environment as well as about the self. All encounters between observers and their surroundings are both environmental and personal events. They occur directly for there is no mediation between the environment and the perceiver.

In this way any mysteriousness surrounding the notion of the “self” is shown to be a function of the inadequacies of traditional theories of perception and not of the unknowability of our persons. If perception of the environment were indirect, based upon the apprehension of mental representations themselves built up from sensory data, then we would not be able to come to know ourselves. Through the sort of external perception conceived of in such theories we might sense our bodies and their movements but not our intentions, affections or goals. These are the aspects that make any self significant and unique.

Those who take this to be a limitation of perception are obliged to hypothesise that the self, or at least our volitions and actions, is somehow known directly through an internal process of apprehension by some form of privileged access.

Whereas we may suppose we know the external world indirectly each can know our own actions and only our own actions directly. This picture has come to pervade science and philosophy and may mislead. For example neurophysiology postulates the existence of a motor command which sends a corollary discharge to another region of the brain as the explanation of how animals can know their own actions and intentions.

Theories of internal self-knowledge may end in either paradox or pure mentalism for no amount of corollary discharge can become self-perception without an observer of the discharge. Thus they are committed to homuncular theories. To explain a homunculus or inner observer, of whatever shape or form, is no more or no less difficult than explaining perceptual awareness in the first place for the inner observer itself stands in need of corollary discharges in order to perceive. Thus the theory of the self that creates an inner self to observe activities of the self is always a homuncular one.

The ecological theory of information based proprioception is very different to this. On the ecological approach observers do not create their own awareness nor do they have an internal self awareness. All forms of external forms of external perception are accompanied by self-perception and not by perception of some abstract mind or of the muscles and joints in the body, but rather by perception of the active, aware self encountering the environment.

The optic, acoustic, chemical and mechanical arrays contain what counts as specific information. The proximal stimuli are simply a symptom of the process of picking up this information. The laws of specificity relate the ecological information to the environment and not the proximal stimulation to its source. Hence every perceptual theory must begin by acknowledging ecological considerations. Because ecological information is external to the organism its existence raises questions about the process of information pick up.

The ecological approach rejects the peripheral pattern of stimulation as the basis of perception. On the ecological approach the basis of perception is the notion of obtained information. Proximal stimulation is incidental to the process of perceiving, that is of obtaining information from the surroundings.

Information then, is both exterospecific and propriospecific. Information is specification not simulation. The reciprocal contents of invariants and transformations are in the forefront of the description of ambient structured energy, whether it be in the optic array or the acoustic array.

In order to be clear about the troubled notion of stimulus Gibson we must make a distinction between stimulus energy and stimulus information. An act of perception does not have a stimulus nor is it touched off by stimulus energy. A sensation however does have a stimulus and is touched off by it. Moreover there is never a one to one correspondence between stimulation and perception. The clearly correct thing to say is that perception is wholly constrained by stimulus information. Perceptual systems are not to be thought of in terms of human communication systems. The inputs of a sensory nerve have nothing to do with messages and similarly the outputs have nothing to do with commands, see SCPS, chapters 1 and 4.

The Detection of Ecological Information

Perception involves the detection of useful information. Useful information is structured energy such as sound that permits the animal to act in and upon its environment. This is the kind of information that is taken as the object of ordinary seeing and hearing where the goal is useful behaviour and so in knowing its natural environment an animal does not merely register visual events. For example the useful aspect of seeing prey is that it may be eaten. Affordances are accordingly thought of and defined actively in terms of something that affords acting upon. Useful information is more than that needed to name or to identify objects. It specifies what those objects mean to perceivers that is what perceivers can do with them.

For each species evolutionary pressure leads to and develops pick up of useful information. A species evolves to deal with its environment in ways that will ensure its survival. Similarly an individual animals learns to deal with its particular environment. These adaptations involve both a selection for certain anatomical attributes compatible with the environment and an increased sensitivity to relevant aspects of the environment. Each species becomes physically and perceptually attuned to their environment through evolution and experience.

Affordances link perception to action. The detection of information tailors the actions of perceivers to their environments. The concept of affordance brings perception and action together in a way that denies common distinctions such as sensory-motor and stimulus-response. A conjoint treatment of perceiving and acting is warranted by the idea that the properties of each are to be rationalised by the other.

For perception to be valuable it must be manifested in appropriate action on the environment. For actions to be appropriate and effective they must be constrained by accurate perception of the environment. The case of colour perception is sometimes offered in opposition to these points but colour perception too is tied to adaptive ends and behaviours in the way required by the ecological approach. If it is objected that colours are not in the environment then it is to be pointed out that colour information is very much part of the perceptual environment described in accordance with the ecological approach.

On the ecological approach the perceiving animal and the acting animal are one and the same and the duties of each are complementary descriptions of the same event. The effectivity structure, the affordance structure and the environment all stand in a reciprocal relationship of mutual constraint. All are information giving and all are information bound.

Information Pick Up

Within the ecological approach "pick up" is a term of art with a particular technical meaning which, nevertheless, relates to the everyday use of the term. Ecological perception is the pick up of perceptual information from this perceptual environment. In the ecological approach information pick up plays the role often given to sensation in sensation based perceptual theories.

Perception is an active achievement of the individual. It involves awareness of something. There is no content of awareness independent of that of which one is aware. This is shown for example when walking round the desks in a classroom and not into them, without taking any notice of them and without paying attention to them. Information pick up is a continuous activity. Perception is continuous. There are no discrete percepts, let alone sense data. The continuous act of perceiving involves the co-perception of the self as in the environment together with the perception of the environment.

Pick up is not equivalent to the integration of inputs. Pick up is the active hunting for external structure that allows the system to achieve an equilibrium. The ecological phenomenon of symmetricalising the source of perceptual pick up is an example of such an activity. For

example if you call to me I move my head such that the sound comes at my ears symmetrically, so allowing optimal use of the acoustic structure, see SCPS, pp. 72 to 73.

The theory of information pick up requires that the visual system be able to detect both persistence and change for places, objects and substances. This may be achieved in various ways. The perceiver may separate change from non-change or may notice what stays the same and what does not or may see the continuing identity of things along with the events in which they participate. This is done when the perceiver extracts the invariants of structure from the flux of perceptual information while still noticing the flux. For the visual system the perceiver tunes in on the invariant structure of the ambient optic array that underlies the changing perspective structure caused by movements of the perceiver. The same account may be given for the persisting identity of another person and also for places, objects and substances.

That perceptual information is picked up does not mean that anything the information specifies is picked up for this would reduce to a stimulus-response theory. In perception what is picked up is perceptual information. This information is perceptual information because to pick it up is to perceive. That this is so means that by dint of perceiving the perceiver has acquired information. The perceptual information is present all around the perceiver in the environment, given freely and openly, and given in great excess. In this way perception is the pick of perceptual information from the perceptual environment.

To say that a perceiver has picked up some perceptual information means that the perceiver is perceiving something. What determines what the perceiver perceives is both the environment, for the perceptual information is a property of the environment, and the perceiver itself. As pick up is direct the perceiver as a whole, namely that which resonates with the environment, can only be the picker-up. The perceiver specifies what is perceived only in this narrow sense.

What specifies the perception and in particular what specifies the content of the perception is for the most part a matter of the perceptual properties present in the environment. The rest is a question of the type and the token of perceiving organism in question. For perceivers this content just is the perceptual information they pick up. A perception is specified by the perceptual information picked up from the environment which in turn is a property of that environment.

Gibson explains pick up in the following, ecological, way,

"The act of picking up information is a continuous act, an activity that is ceaseless and unbroken. The sea of energy in which we live flows and changes without sharp breaks. Even the tiny fraction of this energy that affects the receptors in the eyes, ears, nose, mouth, and skin is a flux, not a sequence. ... perceiving is a stream ... Discrete percepts, like discrete ideas, are as mythical as 'the Jack of Spades'."

- EAVP, p. 240.

That ecological perception is the pick up of information has led some to claim that processing is necessarily part of ecological perception. Such critics cannot conceive of how pick up can be anything other than a process. They do not understand how information pick up can be anything other than a causal process leading to or producing perception.

There are several meanings of the word "information". Where "information" is understood in the ecological sense, information and what is information bearing need not require processing or imply any process whatsoever. The information available in the environment is the information which may partake in perception as a result of direct perceptual pick up.

The ecological approach holds that in perception invariants are picked up. Computationalists refer to raw data that yield zero crossings as invariants. Such things are not ecological invariants. On the ecological approach invariants are features of the environment such as dark objects which may be given in terms of fixed mathematical relationships but stand for much more. As Gibson puts it,

"a compound invariant [a unique combination of invariants] is just another invariant ... if the visual system is capable of extracting invariants from the changing optical array, there is no reason why it should not extract invariants that seem to us highly complex. ... the assumption that higher order optical invariants specify high order affordances is that experimenters, accustomed to working in a laboratory with low order stimulus variables, cannot think of a way to measure them. ... they should not hope to apply an invariant to an observer, only to make it available, for it is not a stimulus. ...

...They do not have to quantify an invariant, to apply numbers to it, but only to give it an exact mathematical description so that other experimenters can make it available to their observers. ... the perceptual system must abstract the invariants. ... Abstraction is invariance detection across objects. But the invariant is only a similarity, not a persistence."

- EAVP, p. 141 and p. 249.

In this way perceiving is a registering of certain definite dimensions of invariance in the optic flow together with definite parameters of disturbance. This fits into the general ecological approach to perception. The invariants are invariants of structure and the disturbances are disturbances of structure where the structure is that of the ambient perceptual array. The invariants specify the persistence of the environment and of the perceiver itself. The disturbances specify the changes in the environment and of oneself. Perceptual pick up depends on the resonance of a perceptual system. It is sensitive to developmental changes and learning procedures.

The ecological approach argues that perception involves the pick up of information that is present in the light, that information pick up involves extraction rather than construction and that perceiving is not a matter of inferring properties of things and events from properties of retinal images. It is a quite separate matter to regard this as providing a complete account of visual perception. There is considerable individual variation in the capacity to extract information.

Since the information available in a given environment is constant, differences in individuals perceptions must be differences in perceivers pick up. These differences may be of an optical nature and bear on the invariants of the environment. This shows up for example in the differences between a human eye and the compound eye of a fly. These differences may be of a social nature and relate to the affordances of the environment. For example a geographer sees different things on a map to a cartographer. Where one may see a glacial deposit the other may admire a finely stippled feature. A third individual may perceive both, namely a finely stippled glacial deposit. The difference is not that one has better eyesight, much less that they are attending to numerically different sensations or sense data. The difference is that one has learned to recognise one thing and the other another thing. According to ecological epistemology this may be put in terms of affordances. One grasps different affordances to the other. One may learn the skill of the other and so come to grasp the same affordances. What we perceive depends not simply on what is present to be perceived but also on our ability to recognise its presence.

Perceptual recognition too is a matter of perceptual pick up. Recognition is frequently thought of a process in which a succession is converted to a simultaneity. Two impressions from different times are said to be compared as if placed next to each other in an image to yield the awareness of similarity or dissimilarity, familiarity or novelty. If perception is based on sensation then the hypothesis of such a process of recognition is reasonable. Many variants of this non-ecological theory have been developed. Computer science for

instance has contributed the concepts of template matching or feature detection in which input arrays are measured against stored knowledge. But on the ecological approach recognition does not have to be like successful matching of a new percept with the trace of an old one. If it did then novelty would have to be the failure to match a new percept with any trace of an old one after an exhaustive search, see SCPS, p. 278.

On the ecological approach the perceptual system picks up or recognises distinct patterns of invariance such as a ratio of chin to forehead size or patterns of convexity, concavity, and intersection in letter forms. These relations constitute true invariant information. Perceptual systems can and do learn to detect them despite changes in type, style or size and changes such as those brought about by ageing.

Through the notion of information pick up the ecological approach explains the basis of various capacities to perceive what is there to be perceived. The ecological approach may say that different organisms perceive differently simply because they are different organisms or because they are the products of different evolutionary histories and thus inhabit different ecological niches or because they have had different past histories and thus have different modes of action or goals or intentions and the like.

Chapter Five: Holism, Reciprocity and Resonance

Ecological Holism

The ecological approach is holistic. This means that it treats the physical world as possessing inherent organisation. Though the physical world is not elementary atoms in a void, the ecological approach accepts analysis and partition for finer structures are seen as nested in more global structures.

This ecological holism is achieved through the existence of ecological reciprocals. The whole relationship between animal and environment, including perception, is treated holistically. Variants and invariants in ecological information are reciprocal to each other, each being detected through discrimination within the perceptual system relative to the other. Structure and relationships are primary in perception, not the identification of individual, absolute values.

Perception is a holistic process involving relational discriminations rather than being atomistic and additive. The brain does not contribute anything to perception beyond being a necessary condition for perception in brain bearing organisms. The relationship between perception and the brain is like the relationship between perception and the heart for chordate organisms.

Ecological holism is to be contrasted with the elementarism of other accounts. Ecological psychological theory challenges elemental empiricism. The basic contrast is between the ecological holistic treatments of physiology, information and the environment and elementaristic theories such as those advanced by Descartes, Berkeley, Muller and Helmholtz.

Perception and mind are to be described ecologically in such a way as to require no reference to sensation. The SCPS puts forward an account generalised so as to cover all five of the senses, vision, hearing, smell, taste, and touch. This account does not exhaust *de jure* questions of epistemology for it is concerned with how things are seen not with whether we are justified in supposing ourselves to see anything at all.

The ecological approach challenges dualism at its very root. On the ecological approach the positivist-empiricist ideal of a dispassionate recorder of facts is a theoretical fiction of dualism. The mind does not stand apart from the world it studies.

Objectivity and Subjectivity on the Ecological Approach

The ecological approach is concerned with the veridicality and objectivity of perception. Perception is something real and objective. In the ecological approach the term "objective" takes on a new,

ecological meaning. The environment is not an intrinsic substance. It is understood relative to animate ways of life. Its reality, objectivity or invariant characteristics exist within an ecosystem involving life. The environment and the animal are reciprocal and evolution in reality is an ecological fact, not simply a fact of life. It involves ecosystems that have evolved.

Identifying perception, including the objects of perception, with the reciprocity of perceiver and environment unit denies the dualist distinction between the subjective and the objective, and rejects the subjectivism common in traditional phenomenology. This does not compromise the ability to describe perception accurately nor to determine what is perceived.

The ecological approach has a careful description and explanation of an ecological reality invoking both subject and object. The terms "subjective" and "objective" take on wholly relative, reciprocal meanings. This is necessary for the description of what is perceived cannot be given independent of an explanation of perception. As a consequence of this it is not possible for the ecological approach to identify sensations with perception.

Gibson sometimes appears to reject the distinction between objective and subjective, and in some senses this is quite right, see EAVP, p. xiii and p. 41. What Gibson actually rejects is not the distinction between objective and subjective but rather any dualistic version of that distinction or any absolute dichotomy between the objective and the subjective.

The ecological approach treats the self and the world as an integrated whole, tied together as a dynamic reciprocity. The self is proprioceived relative to the ambient environment and the environment is perceived relative to the perceiver, see J.J. Gibson, "The Legacies of Koffka's Principles", *Journal of the History of the Behavioural Sciences*, 7, 1971.

The ecological approach respects the distinction between the person perceiving and the object perceived. As Bertrand Russell has argued, to identify the two is like confusing being a nephew with being a person. Being a person does not depend on being a nephew though there are, of course, no nephews who are not persons.

While acknowledging that perception has subjective and objective dimensions the ecological approach resists any dualist analysis. Because exteroception is accompanied by proprioception to perceive the environment is to co-perceive oneself. The awareness of the world and of one's complementary relations to the environment are not separable. Thus to reject the dichotomy between mind and body, and hence that between subject and object, is to reject the idea that mind and body, and hence subject and object, are separate realms.

On the ecological approach subject and object are inseparable and any analysis which separates them by accident or by design is erroneous. They are inseparable because they are identified relative to each other and they are so co-relatively identified because each is identified by its contrast with the other. Gibson describes the relation between the self-produced and the other-produced components of perception as two sides of the same coin, each implying the other. Obverse implies reverse and reverse implies obverse necessarily. The ecological approach like perception occurs in real non-euclidean space. They are, therefore, the concurrent specification of two reciprocal elements.

The fact that the subjective and the objective are distinguished in contrast to each other explains one way in which perception is direct. It is because of this relation that the existence of things as distinct from the self and hence as objective can be perceived directly. Things can be perceived as objective because such things are perceived by the generation of two contrasting perceptual components namely that which is self-produced and that which is other-produced. The identity of the subjective as that which is dependent on the self and the objective as that which is distinct from the self is a product of this perceptual contrast. The objective is, therefore, a component of a perceptual contrast and it is detected by an activity that is perceptual, namely the generation and consequent differentiation between the subjective and the objective. As objectivity is a distinctness from the self and as this distinctness is a part of a perceptual contrast then no post-perceptual processing is needed to make what is directly perceived up into what is objective.

Affordances are relational features of the environment where the relationships involve animate ways of life. The theory of affordances cuts across the subject-object distinction as well as across that between the self and the world. It calls for a different ontology where physical objects do not exist as detached and entire of themselves. They are not like Kantian noumena or like Newtonian physical corpuscles. The mind is ecological and does not reside in a detached ethereal realm.

Commentators such as Cutting and Noble fail to recognise that affordances transcend the subject-object distinction. They treat affordances as if they were simply relations between observers and their environments. This makes affordances a mixture of subjective and objective. This is not part of the ecological approach.

In stressing that affordances transcend the subject-object distinction Gibson insists that affordances are both subjective and objective and neither subjective nor objective. An offering of the environment is not subjective though it is available only to subjects. The fact that only some animals can use a particular affordance does not mean that

affordances are of no value apart from their use. Cows have limited manipulative skills compared to humans but a field of grass is food for cows and not for humans. Compare this with crude oil. Oil in the ground is a valuable energy resource even when untapped. True, oil in the ground has to be recovered but one cannot recover oil from where there is none.

The ecological environment of an organism is therefore to be described in terms of affordances which objectively depend upon both substance and surface properties and fit and support ways of life. For example a rock can be thrown because of its substance and surface properties but throwing requires certain anatomical, physiological, perceptual and behavioural attributes specific only to certain species of animals. Thus proprioception as the subject's awareness of the self, and exteroception as what the subject perceives as distinct from the self, are essential and inseparable aspects of perception. On the ecological approach the term "subjective" may be used to refer to proprioception and the term "objective" may be used to refer to exteroception, see SCPS, p. 200 and EAVP, p. 116.

Thanks to its holistic outlook on the subjective and the objective the ecological approach invites analysis of perception and proprioception as perception of muscular and skeletal position through the close and the ecological relationship between perception and action. This in turn requires an account of exteroception as perception of the external world, and the relationship between the two. It invites an analysis of how the psychological description of an animal relates to its biological description.

Gibson introduced the topic of proprioception through considerations of adaptation and locomotion. A perceiver's ability to know where it is going and where it is presently located depend on certain variants in the series of sampled optic arrays. On the ecological approach proprioception is an ongoing process of the visual perceptual system. The connection between survival and successful locomotion through the environment is evident, as well as the relation between accomplished locomotion and proprioception, see J.J. Gibson, "Visually Controlled Locomotion and Visual Orientation in Animals", *British Journal of Psychology*, 49, 1958.

Exterspecific information concerns the layout of the surfaces in the environment and their concomitant external objects and events. Propriospesific information concerns the animals own bodily movements. Relying on this distinction alone obscures the fact that the animal is in interaction with the environment.

With respect to the interdependence of proprioception and exteroception the ecological approach removes the confusion produced by mentalism and idealism. Though these ways of thinking

have dissipated over time they remain strong enough and common enough to constitute coherent and legitimate concerns for the ecological approach. Such concerns are addressed and discussed in Section B.

Reciprocity in the Ecological Approach

The force driving the ecological approach is the reciprocity of the animal and the environment. This guarantees the operation of the notions discussed within ecological philosophy. With such reciprocity the ecological approach relates the environment to the mind and in particular to the totality of psychological facts. The environment itself is subsumed under the more basic concept of an ecosystem.

The ecological approach treats everything within its purview as existing in reciprocal relations. Nothing exists in isolation. The notion of flow plays a central part. Of central concern to the ecological approach to perception is the reciprocal relation of an animal to its environment.

"the words *animal* and *environment* make an inseparable pair. Each term implies the other. No other could exist without an environment surrounding it. Equally although not so obvious, an environment implies an animal (or at least an organism) to be surrounded."

- EAVP, p. 8.

In one way reciprocity is a straightforward notion. Bees, for example, have colour vision. Plants have coloured petals. The colouration of petals evolves in response to the visual system of the bee. The visual system of the bee evolves in response to the colouration of petals. This is straightforward ecological reciprocity.

In addition to this simple idea, the ecological approach possesses a deeper notion of reciprocity. In the theory of animal-environment reciprocity the term "reciprocity" refers to distinguishable yet mutually supportive realities. Animate life forms and their environment taken together comprise a reciprocally integrated ecosystem. Life functions such as perception and behaviour, necessarily involve animate life forms.

The ecological approach to visual perception involves describing vision as a fact of an ecosystem, rather than just a fact of physiology or the mind. The term "ecological" signifies animal-environment reciprocity. The principle of ecological reciprocity applies to organisms and environments in general. In his developing understanding of an ecosystem Gibson reconciled fundamental ideas such as permanence and change, wholes and parts, knower and known, and space and time as reciprocal pairs. Indeed the experience of perception is not a two term relation but a reciprocal

relation. This is spelled out in ecological theory and through ecological direct realist epistemology.

Though both the animal and the environment are composed of a variety of substances it is their dynamic interdependencies that tie them together into an ecosystem. On the ecological approach affordances and the animal are interdependently, reciprocally defined.

The environment had a potential existence in some respects prior to the existence of life. There was ground (land or sea) and the compositional and structural features of substances and surfaces necessary for affordances existed too, for example the ground possessed degrees of density, rigidity and reflectance. Those relationships which support the affordance reality of the environment did not and could not exist until the animals also existed. So which comes first, the affordance or the animate way of life? The answer is that neither does for both animal and environment share in a reciprocal relationship with respect to perception, see EAVP, pp. 128 to 129.

The task of Gibson's theory of animal-environment reciprocity is to avoid mechanistic reductionism and dualist psychology by functionally interrelating each member of the ecosystem. This requires the ecological approach to explore which environmental conditions afford perception and behaviour and what must perception and behaviour be like given the environment within which life exists. For perception and behaviour differentiated rigid surfaces and a relative homogeneous transparent medium are necessary. The medium provides paths of locomotion and paths of observation. As has been discussed, surfaces support behaviour and are the source of stimulation.

Though Gibson emphasises relationships and differences in his descriptions of structured energy and the environment, he does refer to parts, units, objects and substances. All these terms are to be found in any standard analysis. The ecological approach does not reject such terms but requires that they be interpreted in the context of reciprocity. Parts for example are nested within wholes which are themselves parts nested within larger wholes.

Reciprocity and the Mind

Mentalism, as the doctrine of the mind as separate from some other substance, rejects the physical reductionism of behaviourism and introduces a dualistic ontology. Furthermore, once the restrictions of associationism are removed from psychological relationships information processing theories acquire a rationalistic appearance.

Gibson, largely due to the influence of the Gestaltists, rejected reductionism and from his functionalist background saw the importance of relating together knower and known, subject and object. The ecological approach takes a holistic view of this for with respect to the environment, mind involves global, rather than local, functions of the body. This is in sympathy with an evolutionary view of the organism as a whole.

That the ecological approach rests on the concept of a dynamic animal-environment reciprocity places it against mental monism, physical monism, mind-body and mind-matter dualism.

From the point of view of the ecological approach the mind-body problem rests on a false dichotomy. The environment when not reduced to animal neutral physical variables is tied to the animal ontologically. Equally the animal is more than its molecular or cellular parts. The ecological approach rejects the idea of the mind as a thing distinct from the body in which thoughts, precepts and affective states arising from or influencing emotion occur, see EAVP, p. xiii.

Mind substance and material substance dualism splits ontology into two distinct parts leaving the epistemological problem of explaining if and how they are connected. Dualism produces its epistemological problems from its own ontological commitments. Gibson purposely avoids using the term "mind" because he wishes to avoid being interpreted as a dualist. On the ecological approach the multi-nested and multi-ordered nature of reality offers a way of understanding the relationship of the functioning mind to the functioning body. It is from this philosophical foundation that the ecological approach goes on to offer its functional analyses.

In this way the ecological approach distances itself from both dualism and derivative monisms. It avoids dualism and materialistic monism equally, as well as a totally fluid, chaotic universe or a totally static conception of the cosmos. The ecological approach is holistic and dynamic. It carries the idea of reciprocity throughout.

On the ecological approach perceiving is an activity of the animal and not of the mind or the brain. No specific organ or anatomical location exists in which perception takes place. Perception is the activity of the system. Perceiving is not a response to the environment. Perception involves forms of overt attention such as exploration, adjustment, orientation, and optimisation and also neurological activity. Perceiving need not and does not involve processing or more specifically processing of information.

Reciprocity and Causation

Causality is a micro level phenomenon whereas ecological perception is a macro level phenomenon. Stimulus-response

approaches to perception assume a sequential model of causality. Gibson, following Koffka's critique of behaviourism, opts for the concept of equilibration. Animal and environment are interdependent. The active perceptual system achieves an equilibrium through perceptual resonance with information. The relationship between perceptual information and perception is not a spatio-temporal discrete sequence of cause and effect, see J.J. Gibson, "Direct Visual Perception", *Psychological Bulletin*, 79, 1973, pp. 396 to 397.

The causal theory is often advanced as the scientific account. According to this a representation forms the last link in a causal chain that has its inception in the external object and its ending in the brain. Then it is seen. For it to be so there must be some visual awareness associated with it. Gibson simply asks by whom or by what is it seen ? To whom or to what is the visual awareness to be attributed ? The ecological answers are to no one, to nothing or to a perceiver in an environment. Neuroscientists rely on suppositions of such images and representations. Failure to respond to this point makes visual awareness a puzzling mystery. There is no vision without visual awareness. Without visual awareness there is nothing visual. This is argued for and supported by the ecological approach but may also be adopted by others without full ecological commitments.

Consideration of the ecological theory of animal-environment reciprocity shows why the ecological approach rejected the unidirectional model of causality in the explanation of perception. Reciprocity entails interdependency. Unidirectional causality entails independent causes and dependent effects. Reciprocity entails integration. Unidirectional causality entails discrete events. Both historically and theoretically the concept of reciprocity stands in opposition to dualism and monism, and also to the unidirectional causal theory of perception. Reciprocity is not compatible with unidirectional causality. One consequence of this is that information pick up is not a causal process. It is rather a reciprocal process operating by the mutual procedure of resonance.

In contrast the causal model of perception seeks to explain the relationship of mind and brain. It may be argued that even if perceptual structure is lawfully and unequivocally related to the environment, the perceiver is in effect in direct contact only with the perceptual structure. The environment is spatially and causally separated from the perceiver and perceptual awareness of the environment must be a causal or inferential consequence of stimulation. Perception involves a sequential process of distinct events running from environment to stimulation to neural excitation to perceptual awareness instantiated in mental states. We could equate the neural and mental stages and produce a mind-brain identity thesis but we still appear to be in direct contact only with the stimulation such as the light rather than the environment. Ecological

reciprocity ousts causality from its position as the pivotal relationship in perception and theory of mind. At worst there is no need for the ecological approach to share such causal concerns.

In the ecological approach relationships within perception are circular, reciprocal processes. They are not linear, causal processes. Information is not transmitted through the medium and resonance is not a transmission of impulses from sense organs to brain.

On the causal chain model awareness is an event within a chain, localised at its terminal end within the perceiver. This view is dualistic, placing the mind within the animal, aware of nothing but its inner states. This view is founded upon a reductionistic error in its conceptualisation of perception. It features a confusion of levels of organisation.

Reciprocity, Ontology and Epistemology

The perceiving animal and the environment exist as a reciprocity. The animal is described as an integration of capacities and ways of life actualised within an environment. The animal perceives but perception is ecological. Humans walk but walking occurs within an environment. Perception is animal awareness of the environment. Embedded within this ecological reality are perceptual systems and the activities of such systems and stimulus structure and the relationship of specification. Animals perceive with their perceptual systems. It is not the perceptual system that perceives. Animals perceive veridically because their systems are sensitive to energy relationships but they do not perceive these relationships. Animals perceive what the relationships specify with respect to the environment.

The reciprocal relation of animal and environment exists at a more global level of organisation than those conditions that support their existence. Psychological realities such as perception, behaviour and motivation, exist at this global and ecological level. Stimulation does not cause perception, anymore than atoms cause molecules. Perception is a relationship between an animal and an environment. It is not a relationship between neurons and stimulation. As a relationship achieved by an animal between itself and the environment, it is not a state isolated and localised within the perceiver.

A holistic interpretation underlies the theory that perception is ecological. This holistic organisation is a reciprocity, where the perceiving animal and the perceived environment interface with each other rather than being isolated. They are reciprocal because although each possesses a distinct constituent composition and structure, they possess a set of relational properties necessarily involving the existence of the other. Perception, at this level of

description, is an epistemic relation between the knowing animal and the known or knowable environment that can exist because of their ontological reciprocity. At the ecological level, nothing stands between the perceiver and the environment. There are no physical or sensuous intermediaries in perception.

The perceiver is always aware of both itself and the environment. The theory of ecological reciprocity implies that the animal and the environment are interdependent. The reciprocity of perception and proprioception implies that the animal is fundamentally aware of this reciprocity. The epistemic relationship is between the animal as subject and the ecosystem (the animal-environment system) as object. Knowledge has an ecological support and an ecological epistemic object.

Reciprocity is the characteristic relationship of the ecological approach. There are many ecological reciprocities including those shown on the table below.

Ecological Reciprocities

| | | |
|---|------------------|--|
| A | is reciprocal to | B |
| (as of course, B is reciprocal to A) | | |
| Animal Perceiver/Behaver Ways of life Perception/Proprioception Proprioception Propriospecific information information Perceptual activity stimulation Change Time Transformation Parts/Elements Wholes/Systems Perceptual differentiation constancy Sensory perception behaviour ambience Subjective | | Niche Environment Affordances Behaviour Exteroception Exterspecific Effective Persistence Space Invariant Perceptual Environmental Objective |
| Fact | | Theory |

This list is not exhaustive. Other possible reciprocities are substances and events, deletion (going out of view) and accretion

(coming into view), going out of existence and coming into existence, and surface and the horizon with respect to substance medium and to ground sky, see T. Lombardo, *The Reciprocity of Perceiver and Environment*, p. 364.

The ecological approach takes the concept of reciprocity to tie together permanence and change, units and relationships, temporal and spatial order, and wholes and parts. In particular, and more importantly for us, it ties both the perceiver and the environment (the ontological) and the knower and the known (the epistemological) in reciprocal relationships.

Evolution, as an ecological reciprocity between life and the environment, may encompass a theory of adaptation. Once these factors are understood in their appropriate terms it is then possible to explain ecological direct realism in terms of such reciprocity and such reciprocals.

Ecological Perceptual Resonance

The notion of perceptual resonance is key to the ecological approach to perception. Every approach to perception requires an account of how one perception is perceived rather than another and every approach requires an account of how the perceiver perceives. The ecological approach explains the former in terms of information pick up and the latter in terms of ecological perceptual resonance.

Animals are both animate and sentient. They are not surrounded by an environment in the way that space surrounds a celestial body or the way a forest surrounds a tree. The environment supports animate life providing not only those necessary vegetative and non-cognitive conditions but also supporting both perception and behaviour. In the most general sense its ambient structure affords these animate functions. It is not an empty ambience but a differentiated surround that allows for animal life.

Surfaces surround animals and provide rigid support and differentiated structure making orientation possible. The medium in question (land, sea, air) affords room for locomotion yet it is significant that the medium is adjacent to surfaces and not to unsupported space such that animals move through the medium and across the surfaces. The surface differentiation is reflected in the ambient optic array providing information specific to position and path. Energy reverberates through the differentiated ecosystem surrounding animals with a differentiated energy ambience. The structure within this energy ambience is a consequence of both the surrounding environment and the surrounded perceiver.

The active role of the perceiver in extracting information and invariant patterns, is an important part of the ecological notion of information pick up. Pick up takes place in virtue of perceptual

resonance between the perceiver and the perceptual environment. Without this resonance there can be no perception. Resonance provides the "how" of perception. It is how the ecological perception operates.

A perceiver in an environment perceives in the manner described by the ecological approach in virtue of perceptual resonance. No non-ecological account of perception offers such an explanation. Many accounts leave a gap at this point. Often the supporters of such accounts have not felt a need to consider this relationship and thus have no account of how to bridge the gap between perceiver and environment.

It is sometimes assumed, wrongly, that Gibson uses the term "resonance" simply as a metaphor. Perceptual resonance is not a metaphor but a fact of perception. If it were only a metaphor then there could be no perception.

In explaining the concept of perceptual resonance it is useful to offer an analogy between the ecological perceiver and an operational radio. Electromagnetic radiation fills the space around us. We are attuned to our environment through the optic array such that we are able to perceive as a radio is tuned to a particular frequency of electromagnetic radiation such that it is able to broadcast a sound. The radio is said to resonate with the information available to it in the ambient environment. The medium of the information is electromagnetic radiation. This is analogous to information pick up. The radio and the electromagnetic radiation stand in a relationship such that the radio is able to broadcast sound. All parts of the radio are active. The parts of the radio do not process the sound. No sound-like intermediaries are present. If part of the radio is removed then the radio may fail to produce any sound or may produce meaningless noise. The removed part cannot be said to have been shown to contain or to be the essence of the sound. The sounds are produced by a whole radio with all of its components complete. If certain components are missing or damaged or worn then noise may be audible but not the sound that would otherwise occur.

As organisms in environments, human beings and other animals are active perceivers. They are tuned by development and by learning. In perception information is obtained not imposed. Though the structure of the nervous system may be described mathematically, no numbers are manipulated by the nervous system. The mathematical relationships are built into the structure in a particular way as a result of the biology of the systems.

If the surrounding environment is reciprocal to the surrounded animal then there is always a component of proprioception in perception such that there is always some awareness of the environment in perception. The environment is never perceived entirely without

reference to the perceiver for there is no perceptual environment entirely independent of the perceiver. In addition to this there is a here and now relativity about reality that exists in varying degrees in perception. An animal may move about and watch things over a period of time but the objectivity and invariant quality of the perceived environment is relative to that animal. For the perceiver and hence for perception there is no omnipresent, eternal viewpoint and, conversely, there is no view from nowhere, see J.J. Gibson, "Visualizing Conceived as Visual Apprehending Without any Particular Point of Observation", *Leonardo*, 7, 1974.

The notion of perceptual resonance has several consequences for the ecological analysis of the nature of perception. The perception of familiarity or sameness is for instance based on the resonance of a perceptual system with invariants amidst changing perceptual arrays and that perceived difference reflects either the absence of such an invariant or the inability of the system to detect the relevant invariance, see R. Shaw and J. Pittenger, "On Perceiving Change", in H. Pick and R. Saltzman (editors), *Modes of Perceiving and Processing Information*, 1978.

There is, of course, the question of the soundness of the notion of perceptual resonance. Perception and perceptual resonance has, for instance, been likened to transduction especially with respect to the concept of perceptual information. This is a misnomer. Perceptual resonance is a property of the reciprocal relationship between a perceiver and the perceiver's environment. In contrast to this a transducer is a device that transfers power from one system to another in the same or in different form. It lacks any notion of reciprocity. Its role is as a type of putative perceptual system transferring light energy into perceptual energy in order to power, or allow the production of, perceptions. Such an idea is not part of the ecological approach.

The ecological approach is able to provide a perfectly valid, integrated account of ecological resonance together with appropriate reassurances. Resonance is a reciprocal rather than a causal notion. Resonance can only be thought of in a circular and not in a unidirectional way. The perceiver and the environment are responsible for perception. They do not cause perception. Information pick up is responsible for perception. It does not cause perception. It is not correct to say that information pick up causes perception in the perceiver. To say this is to deny the reciprocal relationship between the perceiver and the environment. Perception is ecological and as such is to be analysed in ecological terms.

That the activity of perception involves resonance means that it is holistic, continuous, active, selective, ecological, involves adjustments and equilibration, and is circular rather than unidirectional. Resonance between the animal and the environment

standing in a reciprocal relationship makes information pick up possible. No processing is required. Perception occurs directly for perceptual resonance relates directly to perceptual systems, see J.J. Gibson, "The Problems of Information Pick Up", Purple Peril, 1971.

Awareness and Consciousness

According to the ecological approach the success or failure of the behaviour of an organism bears witness to the scope and accuracy of its perception of its environment. The flourishing of a particular organism indicates extensive knowledge of the environment of the organism achieved as a result of the perceptions of that organism. Organisms perceive their surroundings sufficiently well to guide discriminating actions such as avoiding collisions and gathering food. To this extent an ecological theory of perception is a theory of how and to what extent the environment is known.

The term "awareness" is used by Gibson to imply immediate pick up as opposed to conscious pick up. It does not require being conscious of what is picked up. For the latter case Gibson uses the terms "conscious awareness" and "apprehension". By contrast to the changing phenomena of perception what we experience, our experience of perception, remains quite rigid. We perceive from the same place. We say this place is "in our heads" and always in the same place "in our heads".

In this way our knowledge of the external world is knowledge of the environment which in turn is perceptual knowledge and as such is not supplemented in any way. In particular it is not supplemented by inference, memories or representations. This stands apart from knowledge about the environment which as knowledge of something else may involve these things.

If to describe the facts of awareness is to try to explain them then the ecological description of what is perceived captures both its significance to the perceiving animal namely its meaningfulness and relation to the living form, and its objectivity. Such description requires an ecological theory of reality run on the basis of animal-environment reciprocity.

What is fundamental to perception is the role of consciousness. On a sensation based approach it is obvious that vision has to be conscious because whatever else they are, sensations are conscious.

Within perception there is a distinction between consciousness and awareness. I may for instance be conscious of perceiving the Mona Lisa whereas I may be aware of perceiving the walls of the Louvre and not be conscious of perceiving them. It is taken that certain animals such as dogs and birds are perceptually aware but not

perceptually conscious. It would seem we cannot say the same for robots. Robots are neither conscious nor aware. It is not satisfactory to state that robots are in some way not ecologically valid for if a robot could resonate reciprocally with the ecological environment in the way that other perceivers do then there is no reason not to say that the robot is a perceiver too. It is a further step to argue that the robot is conscious in the way that we are. It would only be possible to say that the robot perceives without being aware of what it perceives. It would not be possible to say that the robot is aware of an object of its perception.

The onus of answering the question why robots cannot pick up perceptual information and resonate with the perceptual environment rests on the discipline of cybernetics. As to whether robots can ever be perceptually aware or conscious, however, the ecological approach holds that they can be so long as they take part in appropriate perceptual resonance within a reciprocal relationship with their environment.

One test would be that they refer to their perceptions in the way that we do without any recourse to computation or processing in their perceivings. This is possible if we regard evolutionary considerations as applying to technology as well as to biology.

It may be argued that it is not obvious that the ecological approach explains how vision can be conscious. Consider a blindsighted person who can point to a light source in the blind field. Is this a case of direct pick of information? If it is not then we need an explanation of why it is not since the subject is able to act with respect to a particular feature of the ambient array. Alternatively if blindsight does involve the direct pick up of information then how are we to explain what differentiates blindsight from standard sight? The ecological explanation begins by pointing out that blindsight is a case of dysfunctional vision. Here there is information pick up but not as much or in the same way as for cases of non-dysfunctional vision. Blindsight observations are a question of the amount and the sort of information the perceiver is able to pick up.

This clarification shows one explanatory benefit of thinking about perceptual content in terms of ecological perceptual information rather than in terms of grasp or possession of all or nothing concepts say. In general the conscious nature of perception shows up through the pick up of affordances and subsequent reports, actions and behaviours.

The environment provides an organism with an extremely rich flow of information and provides a precise enough specification of the environment so that the organism need only pick up that information. Whether the organism is able to pick up such information is a separate issue.

Perception requires an organism in an environment and that the organism and the environment partake of a reciprocal relationship involving perceptual resonance. Whatever satisfies these conditions takes part in perception. This goes for any physical phenomenon that may be environment bound, such as humans, animals, robots, stones and galaxies. This may or may not involve conscious perceptions or perceptual awareness.

Ecological direct perception recognises the richness of perceptual experience and holds the basis of this to be the richness of the perceptual information available and not the elaboration of perceptual information. In this way our perceptual experiences are shown to depend on the nature and description of the perceptual environment around us. Further elaboration is neither needed nor is it appropriate.

Chapter Six: Ecology and Perception

Perceptual Modalities

The perceptual modalities are of vital importance to all perceivers in every environment. They are intimately related to each other and the ecological approach is especially sensitive to this. For human and similar perceivers a vital component of the field of view is the organism's own hands and arms that extend from close to the lateral limits of the field and which can be monitored and guided in their complex actions with respect to the surfaces of substances in the environment.

This sort of description of our own appendages seems remote and incomplete because we are also sensitive to the correlated mechanical energy generated by our own bodily and haptic activity. The pup or kitten which chases its own tail may sustain a few self-inflicted wounds before the invariance of this particular visual and kinaesthetic event is discovered. Similarly the experience of paralysis or anaesthesia, such as having a dead arm, is enough to make us perceive our own body parts as attached objects. There is nothing necessarily integral about the experienced body. For the most part it is experienced as a unified system because of the maintenance of perceptual sensitivity to invariant patterns.

Part of our self-conscious knowledge is that we possess distinguishable bodily features differentially sensitive to the environment. To say there is some visual quality about visual perception that is distinguishable from the tangible perceptions of touch is to draw attention to what we normally perceive. It is to express the fact that when adopting a self-conscious attitude we attend to the fact that we can attend to the world with our hands separately from our eyes. It is this ability that allowed empiricists to conceive of space perception as the combination of independent visual and tactile sensations.

Ecological perception is ongoing information pick up in the real and purposive world. It does not have the detached character of self-conscious empirical observations. In straightforward perception this self-conscious distinction does not operate except in circumstances where we are prevented from simultaneously attending to the world from our head and hands. Tasks such as playing a compact disc or changing a light bulb entail the momentary disconnection of visual and haptic modes of attention. Attention to these modes is typically correlated and represents a higher order invariance. The ecological approach stresses the unity of the perceptual modalities accounting for cases of modal separation as deviations from the norm. In this sense it may be considered to embrace Kant's transcendental unity of apperception.

From an experimental point of view, the ecological approach covers all of the perceptual modalities. There is a well worked out theory for visual perception and there are also ones for audition and for touch. There is some evidence that smelling and tasting may be accounted for ecologically too. The ecological approach to perception does not disprove cognitive processing but holds rather that cognitive processing is no part of perception.

According to the ecological approach visual perception is direct perception. What about the other perceptual modalities ? The distinctions are not easy to make. It is important to distinguish between the perceptual sense modalities and cognition. We may also examine the organ of sense for each modality. The theoretical and empirical evidence points to following assessment :

| | Ecologically Direct ? | Organ |
|-----------------|------------------------------|--|
| Vision | YES | Eye |
| Audition | YES | Ear |
| Touch | YES? | Skin |
| Taste | NO?? | Tongue and palette |
| Smell | NO? | Nasal passage and Back of the Mouth |

The ecological approach for vision lends itself to audition. Much work has already been done on the ecological approach to audition, see W. Gaver, "How do we Hear in the World ?", Ecological Psychology, 5, 1993. Touch too may be embraced by an ecological haptic theory which fits the general pattern of the ecological approach.

In the above sense, visual perception is direct cognition. Audition is very similar. Filtering sounds for instance, such as attending to the speaker in front of you and not the music on the radio, can be accounted for by pick up of auditory invariants and affordances. Touch is more direct for there is no intermediary between the surface detected and the body which detects. This would suggest that tactile perception is direct perception.

From the empirical point of view taste and smell are constrained by both cognitive and physical factors. Both need to be alerted before they may function. Taste is constrained by the digestive system and smell is constrained by the respiratory system. The requirements for cognitive and physical preparedness indicate a place for indirectness in the accounts of both taste and smell. These are not requirements for the ecological account of vision, audition or touch. Perhaps there are ecological indirect accounts to be given of taste and smell. There

is no reason why one perceptual system should not have evolved to perceive directly while others evolved to perceive indirectly.

The modes of sense are importantly different. Not all strike us as obviously direct. The relationships between the perceptual modalities and cognition are not uniform yet there may well be an ecological way to understand all of them.

One consequence of the ecological analysis of the perceptual modalities is that some but perhaps not every combination of cross-modal information is possible. There seems to be some information that is available across certain modalities but not across others. Both shape and colour for instance are ecological properties. Shape properties are detectable by both sight and touch whereas colour properties are detectable by sight only. Why this should be so is a problem for the ecological theory of the perceptual modalities.

The centrality of the notion of cross-modal invariants turns on our understanding of what exactly is specified. With looming for instance there is a unique lawful relation between time-to-contact and parameters of optical and acoustic stimulation. Empirical analysis usually takes the form of mathematical formulae relating time-to-contact to the rate of expansion of the image of an object or surface. Discussions of impending collision treat this invariant in isolation without reference to ecological factors.

The perceptual systems are always operating. None of these systems ever shut down. Organisms pick up information through multiple perceptual systems during every living moment. In addition the pattern of information across perceptual systems is specific and informative. This may be used to argue for the existence of independent, discrete, cross-modal invariants.

Given the nature of the perceptual modalities and the existence of such cross-modal invariants we are then able to give an ecological explanation of why, for instance, shape properties are detectable by both sight and touch whereas colour properties are detectable by sight only. Here there would be a cross-modal invariant for shape with respect to sight and touch the pick up of which provides perceptual information in a visual and tactile form. This invariant is distinct from the perceptual invariant and from the tactile invariant. For evolutionary and ecological reasons no such cross-modal invariant exists for colour with respect to sight and touch. This may simply be because no such tactile invariant exists for colour. Such an invariant may be ruled out by physical science, may evolve in the future or may exist to be picked up for another species. In our current environment there is no problem about the complexity of invariants. Such problems have been resolved by evolution and ecology.

This ecological analysis of the perceptual modalities applies to all ordinary events including fires and collisions. Organisms do not perceive the activities of perceptual systems or individual sources of information. Organisms perceive events. An organism will not for example perceive the visual specification of a collision. It will perceive the event of a collision as specified by the perceptual circumstances.

It may be objected that with multiple perceptual invariants events are multiply redundantly specified in the information picked up by the different perceptual modalities. What is specified by the different invariants, however, is different information. If you see fire, hear fire, smell fire and feel fire you pick up different pieces of perceptual information. In this way you have perceived the fire in four different ways. You have not had the same perception of fire four times over. Now consider the case of impending collision. Imagine yourself tied to a railway line as the express approaches. You see, hear and feel the approach through ground and air. It is likely that some time-to-contact information is available from the pick up of each modal invariant. Whether some or all of this information is present or whether some of this information is duplicated your perception is of a single oncoming train and is specified as such.

The perception of an actual event rather than some isolated property of that event is dependent on the pattern of ecological information distributed across the perceptual systems. Different patterns specify different perceptions. They are uniquely related to different events.

Many cross-modal patterns are informative about events in ways that unimodal patterns are not. There is always an overall pattern of information distributed across perceptual systems. Not all of this may be picked up. Events that do not engage multiple perceptual modalities may nonetheless be perceived veridically. A silent ball flying through the air may be caught without recourse to perceptual information from another perceptual modality. On the ecological approach the total pattern of information across all modalities specifies the entire perceptual situation of the environment. All or some of this information may be picked up by a perceiver.

Ecological Misperception

Misperception in the ecological approach may be the result of either a lack of learning or a mix up at the level of affordances. Misperception as a lack of learning is the absence of affordances. As a confusion at the level of affordances, misperception is the failure to pick up all the information relevant to the actual environmental situation, such as when a bird flies into a pane of glass. We may refer to this as *veridical but deficit* perception.

In this way ecological misperception is to a failure to pick up the correct perceptual information where this information is present in the environment. This can be explained as a failure to pick up certain invariants or as a failure to pick up the appropriate, or indeed any, affordance.

Neither the ecological explanation of misperception as a lack of learning or as a mix up at the level of affordances fits common explanations of misperception. On non-ecological approaches misperception is taken to be not perceiving what the perceiver thinks they are perceiving. In this way misperception is made an epistemological matter rather than a perceptual one. The ecological approach has a straightforward explanation of this for you are always perceiving what you are perceiving in the prescribed ecological manner even if what you are actually perceiving is not what you would describe yourself as perceiving or act as though you are perceiving.

The ecological approach has room for perceptual dysfunctions. On the ecological account blindness, colourblindness, blindsight and similar perceptual conditions are organic failures of physiological systems that enable perceptual information pick up. These physiological conditions may be corrected by surgery and subsequent perception may function straightforwardly. These dysfunctions are physiological and anatomical. As such they are not ecological and do not have a place in the account of perception.

These dysfunctions are compatible with ecological direct perception. Take colourblindness for instance. Whenever we perceive the colour of a surface we may say that we perceive the invariant colour that remains unchanged during any changes produced by the perceiver or by the environment. What remains invariant is objective. A person who is colourblind, one for example who sees green as grey, can nevertheless perceive the invariant grey and what is invariant is objective. The colourblind person cannot discriminate as well as one whose vision is not so impaired yet both perceive what is objective. Colourblindness is therefore a failure to see something and is not the perception of something that does not exist. In this case it is a failure to pick up the information that specifies objects as green. The grey seen by the colourblind person is not a non-existent colour. It is simply a case where the perceptual information picked up by the particular perceptual system reveals the particular objective invariant structure as grey. The differences of information in these cases may be differences by omission. Such differences in no way change the objective nature of perception.

A different sort of problem is shown up by cases of blindsight. What is clear with blindsight is that there is some information pick up. Blindsight is a dysfunction and it is possible that this dysfunction is such that the perceiver is able to pick up some perceptual

information but does not enter into a reciprocal relationship of resonance such that the perceiver is able to be aware of the information that has been picked up. This does not mean that perception is not direct for the blindsighted perceiver stands in a direct relationship to the information that is picked up. Should the condition be treated successfully then a sufficient relationship of resonance would obtain and the perceiver would be aware of the information picked up.

The ecological account is able to deliver perceptual consciousness in a way that fits perceptual phenomena. That certain dysfunctions may disable particular perceptual capacities, sometimes in a way that does not strike us as straightforward, does not alter this fact. If the resonance relationship has been affected then the perception will be affected. The anatomical, physiological and social nature of such dysfunctions is a matter for medical analysis. The perceptual outcomes are to be analysed according to the ecological approach.

What the ecological approach must resist is the idea that misperception is the result of a mistake in perceptual processing or some other consequence of an indirect account of perception. This non-ecological analysis is characterised by saying that the result perceived was somehow in error compared to what was there to be seen in the environment. The ecological approach offers a distinct account of perception.

In every case of putative misperception that we have considered the label "in error" is inappropriate. This has been demonstrated by a careful analysis of the circumstances on the terms of the ecological approach. In such cases there may have been a misdescription of the circumstances. There may have been other non-perceptual circumstances such as drugs or lesions to the brain which are relevant to the particular case.

What the ecological approach requires is that perception operates as a form of direct cognition. The ecological approach does not argue that all cognition must be direct. In general, the ecological approach explains misperceptions in terms of affordances. All other putative cases of misperception are either in fact mislabelled or are not cases of perception at all.

Ecological Approach Perceptual Development

The ecological approach is concerned with all behaviour both physical action and cognitive activity. It is unique in its emphasis of the reciprocity of organism and environment. The study of perceptual development is an excellent way to examine this reciprocal relationship asking how the interaction comes about and how it progresses in complexity. Thinking and experimentation about the development of actions such as communication, use of objects, development of perception and problem solving provide a basis for

an ecological account of the development of human behaviour. The ecological hallmarks of perceptual development that emerge are control or agency, prospectivity or forward-looking direction of activity, flexibility or transfer of means and strategies and communication or expansion of socially mediated learning, see E.J. Gibson, OLP, 1991.

These properties of behaviour do not appear in stages but progress with changes in the interaction of an organism with its environment. There are no final causes for such development. Many factors both internal and external contribute to dynamic interactions.

The task for development is to improve the fit between the organism and the environment to allow for efficient smooth and co-ordinated actions. By active movement an infant learns about properties to be solved that arise when co-ordinating with the external world and about information that makes it possible to steer the action in a prospective way. This ecological functional approach focuses on two kinds of questions,

- a) Predictive behaviour is assumed to reflect central aspects of perceptual and cognitive development and is subject to research, and
- b) Different tasks involve different kinds of problems and the infant may be prepared to solve certain problems in certain contexts but not in others.

This constitutes the ecological functional explanation of the mind. Structural questions relating to faculties such as memory and attention are less relevant to the direct ecological approach but are related to the functional questions raised.

Given this framework the ecological approach to perceptual development may be put so,

1) Animal and Environment Reciprocity

On the ecological approach the proper unit of study is an animal in the environment in which it has evolved in a reciprocal relationship.

2) Perception and Action

Perception and action are interdependent. They share a cyclical relationship. Perception obtains information for action and action has consequences that inform perception both about the self and about the events that it perpetrates.

3) Species-Typical Environments

With respect to development learning must be studied in environments typical of that species.

4) Learning

The ecological approach to learning takes the view that one could say that if perception is taken as knowing the environment then perceptual learning is how we get better at knowing the environment. For every species this improvement is to be understood with reference to evolution. For each individual the improvement is to be understood with reference to individual experience which may include communication from other individuals. Evolutionary learning and individual learning operate in an analogous manner in that both serve to make animals better able to detect the affordances available in the environment. Evolution produces a pre-attunement of perceptual systems to ecologically significant perceptual information. Learning is the education of attention to this information. Through some structural change in their nervous system learners become able to resonate with additional information present in the environment. These considerations coupled with the idea of affordances provides a general ecological approach to learning set out in the following way,

i) What is Learned

What is learned in general is the perception of affordances. This involves learning to perceive what an object or an event or a layout affords for action in relation to oneself. Where the information specifying the affordance is available the meanings provided by the affordance are perceived directly. The meanings can be perceived indirectly when the information specifying them is selected and displayed in one or another form of representation, for example by using pictures or by using language. The pictures and the words are meaningful but in a way that is historical and cultural as well as ecological. Social and individual cognition and awareness may be mixed.

ii) When Learning Occurs

When learning occurs depends on the maturation of action systems. They are a rate determining factor for perceptual learning and development.

iii) How Learning Occurs

How learning occurs is by exploratory use of the developing systems and the observation of the consequences. Both children and adults guide their perceptions with language using such phrases as "look at that". They guide their language with perception and use of perceptual demonstratives of the form "that is a such and such".

5) Exploration

Exploration is a natural function of the developing system. An animal forages for information about self and environment.

6) Control

Learning to perceive and to instantiate an affordance is an example of gaining control of that behaviour. It can henceforth be used intentionally.

7) Prospectivity

As control increases so does prospectivity of behaviour. Prospectivity is the anticipatory aspect of control.

8) Potential Flexibility

As exploratory range, control of new affordances and prospectivity increase so does the potential flexibility of behaviour.

9) Task Setting

Behaviour occurs within a task setting. Tasks are set naturally in early life by the demands of maintaining life and growth within the niche such as breathing, eating, maintaining comfort and making contact with the world. They differentiate the development.

10) Tasks and Affordances

Tasks expand as new affordances are learned, as exploratory action broadens and as social contacts are made. Goals vary with task expansion.

11) Means to Ends

Means to ends are learned. This is one kind of higher order affordance relationship. Selectivity is increased as the relations between means and ends are learned.

12) Increasing Flexibility

As means and ends relations multiply and differentiate so behaviour becomes increasingly flexible.

13) Transfer of Means

For transfer of means to occur there must be affordance and task linkages. This generally involves active perceptual learning. In this

way affordances are linked to the consequences of perceptual learning.

In this way the ecological approach may be pursued through the ecological study of perceptual development. Indeed the theory of ecological perceptual development incorporates much from the theory of ecological direct perception. In particular, ecological perceptual development holds that,

- a) The information available to the perceptual systems is sufficient to specify the environment,
- b) Information pick up results in the perception of affordances,
- c) Information pick up and the perception of affordances are constrained by both phylogeny and ontogeny, and
- d) Cognitive constructs such as mental representations are unnecessary and misleading in the explanation of perception.

In general the ecological approach assumes that perception and cognition are continuous so emphasising the mutuality of organism and environment. This means that development consists of changes in the relation between the organism and the environment and not on changes in the organism or the behaviour of the organism.

Development is therefore seen as a co-creative process between the organism and the environment where the minimum unit of analysis is the relationship between the organism and the environment. On the ecological approach it is possible to construct a theory and model that is entirely relational, investigating organisms on the basis of what is known about the forms of their relationships to the environment.

The Ecological Approach to Perception: A Summary

Before moving on to examine the philosophical issues at stake in the development of an ecological philosophy, a summary of the ecological approach to perception is appropriate.

- 1) Perception is based on information not sensation. This information is available in the world. Information about the world is obtained through the activity of perceptual systems. Information does not simply emerge nor does it impress itself upon the mind at birth.
- 2) Information about the world may be obtained and may continue to be obtained by perceptual information pick up. The activity of information pick up may improve with practice. This improvement constitutes perceptual learning. This information is not stored in

the memory. The information continues to be externally available. Perception is not a mental construction.

- 3) The world does not exist in the mind. The independent, rational mind is a myth. The inborn mind of nativism is a fallacy.
- 4) Perception does not come through the sense organs. The sense organs are components of perceptual systems that extract invariants from the flux of stimulus flow surrounding the perceiver. Invariants are specific to the world but not to the receptors that are stimulated.
- 5) Perception is a reciprocity between the perceiver and the ambient environment of the perceiver. It occurs continuously. Impulses in the sensory nerves are not signals. The nerves are not channels for communication.
- 6) Perceiving is active. It is to be conceived of as an act of becoming aware of the environment. Perception is an act of picking up information about the environment. Perception is active. It is not passive for it is not delivered to the perceiver by the environment. Perceptual activity is to be understood as intentional. The perceiver is an explorer who searches out information about the world. This reflects the dynamic view of reality insofar as order and lawfulness are not found within static and independent particulars but across transforming and interdependent particulars.
- 7) Perception of the environment is necessarily accompanied by co-perception of the self in the environment. Each entails the other. The perceptual systems obtain information about the self along with information about the world.

Having undertaken this work we may now move on to examine the philosophical doctrines underlying the ecological approach in a full and methodical way. This examination gives rise to the philosophical position known as the ecological philosophy of perception and mind.

SECTION B: THE ECOLOGICAL APPROACH AND PHILOSOPHY

Chapter Seven: Philosophy and Perception

It is common for philosophy to view the physical world as a set of unrelated particulars and hence as intrinsically meaningless. Here both order and meaning are imposed on the world. If this means that we can only know the immediate contents of our mind or of consciousness then our thoughts can spawn new thoughts only about themselves and not about anything outside themselves. Thus there is no intentionality, no aboutness, in, or available from, the world outside the self. This then may be described as an epistemic dead end. The ecological approach describes the environment in such a way that perception involves the environment revealing itself to the perceiver. In this way the environment is rendered meaningful.

Both philosophy and science have attempted to treat animals as objects, subject to the laws and descriptive concepts of mechanics. Both stimulus-response analyses and mechanistic physiology view psychological processes as purely dependent reactions within a causal chain where animals are simply objects that move.

Not only are the spatial and temporal scales in physics inappropriate to ecological analyses for animals within an environment constitutes a different kind of relationship than objects in space. Animals move about in a differentiated ambience. Objects, by contrast, move through a relatively undifferentiated emptiness. The environment acts as an absolute frame of reference and a surface of support. Space has a relative and variable frame of reference without a demarcated surface layout. Animal behaviour is not analogous or reducible to mechanical motions. Animals orient to the environmental frame of reference and control their behaviour relative to what they perceive. Behaviour is elastic, intentional and multi-nested in complexity. It cannot be reduced to rigid translations through space. Ecologically, there are no behavioural atoms. Behaviour is not controlled through physical forces but by means of ecological information. This ecological nesting is not purely hierarchical because there are transitions and overlaps between size levels.

Animals control, manipulate and modify the environment in various ways. Animal behaviour is not motion reactive to independent external causes. Behaviour should be described as co-ordinated in organisation and function.

Many theories hold perception to be mediated and indirect. This usually involves a sensation based analysis of perception. The environment impacts upon the body causing sensations which, when suitably modified, produce perceptions. According to these approaches perception may involve the intervention of representations and memories. Such accounts are popular with

philosophers, psychologists and cognitive scientists. They imply that perceptions always involve the embellishment or elaboration of an always inadequate stimulus input. The ecological approach holds that perceptual stimulation or information is extremely rich and due to evolution and ecology provides such a precise and exact specification of the environment that a perceiver need only detect that information and need not elaborate it.

Many indirect theories of perception hold that perception should be described as an inferential process from evidence statements couched in the vocabulary of predicates referring to putatively basic energy variables to belief statements couched in the indefinitely large vocabulary of predicates referring exclusively to properties of the environment that are relevant to activity. On the ecological approach perceptions are non-propositional.

Many critics of the ecological approach work with information processing and computer simulation models of cognition both of which have become extremely influential in philosophy and psychology. The computer model suggests that the brain performs computations on input and so synthesises this information. The computer model suggests that the brain performs computations on input and so synthesises this information. Such models adopt a rationalistic rule governed theory of the mind. Gibson believed that the information processing approach reflected in new terms the traditional explanations of perception he had long criticised as conceptually mistaken. There is nothing fundamentally new in the information processing approach. Conversely, advocates of the computational approach do not see anything new in the ecological approach, just a redescription of the perceptual layout that fails to explain anything beyond the fact of perception itself.

Computer science and information processing speak of systems but there are significant differences in how systems may be defined and understood. A computer system is given information as its input and the system organises such information, giving it order. This information is expressed in terms of computational calculations. In this way information in computer models has a significantly different meaning from information in the ecological approach. In computer models information has a mathematical form. In the ecological approach information is ecological and perceptual. It is not mathematical.

The position of psychophysics and cognitive science is that there is abundant evidence of anatomical and physiological data being used for perceptual phenomena such as dark adaptation and visual masking. These cases are instances of explanations of perceptual phenomena in terms of physiology. If such explanations are permissible then perception cannot be direct because physiological processes must intervene between the environment and the percept.

Perceptual research within cognitive science has its own particular form studying the flow of information through the nervous system, especially the brain, and so involving the areas of attention, perception, memory and mental representation.

Within the framework of cognitive science perception is viewed as one aspect of a larger cognitive system. This requires an account of the mechanisms by which perception of one stimulus is affected by the perception of other stimuli presented nearby in space or time. Such a concern rules out the notion that perception can be direct. The philosophical account of the ecological approach meets these points through its account of ecological realism.

Many critics of the ecological approach use the language and concepts of computer theory and the information processing approach. A considerable portion of the criticism so raised does not address the fundamental ecological and evolutionary issues. Such criticism serves to re-iterate non-ecological views.

The Ecological Approach and the History of Philosophy

The ecological approach arose from the consideration of biological facts. It offers the opportunity for the development of a philosophy founded on biological, and evolutionary, knowledge. That this should be an attractive proposition is demonstrated by consideration of the work of Aristotle who founded both empirical philosophy and empirical science from such grounds. Empiricism is the common root of both his philosophy and his science. This empiricism is the key to understanding both philosophy and science. That this should matter to philosophy is clear. For a start all philosophers are biological beings and further, the subject of philosophy, that is the thinking human condition, arises from the existence of biological facts. It would therefore be foolish to ignore such a connection.

Many current philosophers will react against this. A division has occurred in philosophy. Plato practised philosophy in a very wide ranging sense incorporating what are now seen as science and religion. Aristotle understood this clearly and distinctly having as philosophy (that relating to the mind, to psychology), religion, science and mathematics. It is from Aristotle that we derive our notion of analytic philosophy, of what philosophy discusses and how it discusses it. Aristotle put philosophy on the footing of biological fact.

Modern philosophy picks up the ancients's empirical thread but places philosophy on the footing of religion. Descartes insisted that I am not like a captain in my ship and introduced the conceptually (as opposed to actually) distinct *res cogitans*. Locke concentrated on the empirical but saw the scientific as distinct and shied away from giving philosophy any footing other than a notion of innateness given

ad hoc support. Hume tidied this up but was driven to the scepticism that had caused Descartes to resort to notions of God. Berkeley picked up and developed Descartes's notions and developed the religious footing to a considerable extent. Kant took Descartes's rationalism, Hume's empiricism, largely shunned Locke's non-coherent appeal to science, and encapsulated Berkeley's religiously motivated idealism. He produced a very sophisticated philosophy founded on religion.

Following Hegel, Marx and Nietzsche, among others, the notion of religious foundations became unfashionable and by 1900 was widely considered to be untenable. Though Bradley's idealism emerged with strong support the main, influential work was done by Frege who sought to put philosophy on a logico-mathematical footing. This was followed by Russell and the Logicians, and latterly by others such as Peter Strawson, and John McDowell.

At around this time psychology as an experimental science split from philosophy, putting philosophical ideas of mind on a scientific footing. This showed the failure of philosophy to address these matters from a satisfactory point of view, ie on a biological, ecological footing.

Bringing things up to date, Peacocke combines Neo-Fregean logico-mathematics with Kantian metaphysics by the use of notions from psychology and spurning any religious foundation. In short, he considers Kant's philosophy in terms from psychology replacing the religious footing with a logico-mathematical footing. This as it involves psychological notions is claimed as an empirical philosophy. It is no such thing.

The only philosophy with true claims to be the heir of Aristotelian empiricism is that placed on a biological, ecological, footing. The was practised by Aristotle and perhaps attempted by others. Descartes was misled by his religious footing. Kant incorporated this footing. Hume had a non-biological, non-science based empiricism which led to an austere philosophical conception. Frege replaced the religious footing with a mathematical, logical footing. Neo-Fregeans, adopting terms of empirical psychology found their philosophy on a similar quasi-mathematical, quasi-logical footing.

Now that the biological sciences have developed independently in separate space we are able to see how philosophy has been taken from Aristotle's founding conception of a discipline with a biological, ecological footing. It is now possible to return and restore philosophy to this footing and bring it up to date with current biological science and experimental psychological. This is done through the adoption of a thoroughgoing footing of an ecological approach.

Philosophical Theories and Ecological Philosophy

"Nativism, rationalism, empiricism, and Gestalt psychology. They are all wrong ! All sensation-based theories of perception. I have an information-based theory of perception."

- Gibson Archive, Cornell, 10.31, 1963

Gibson objects to all such theories because of the way they try to understand what the natural world is like. Ecological optics, the theory of ecological information, the ecological description of the environment and the concept of affordances combine to form Gibson's reply. They are all important parts of the ontology, epistemology and realism of the ecological approach.

For Gibson the study of perception and perceivers in indirect and dualistic terms leads to inherent contradiction. Idealism fares no better for it leads to solipsism. Materialism, as the antithesis of idealism, leaves us trapped in our brains viewing copies or representations of the world. Gibson argues that because perceivers are active they are to be studied as they freely engage in the activity of perceiving. This is an important methodological principle of the ecological approach.

According to the ecological approach what is perceived is to be considered in relation to a perceiver. In ecological optics the decision to consider the structure of light at a level at which it can afford information about surfaces is determined by consideration of the light in relation to the perceiver.

The ecological account of perception is delivered in virtue of perceptual layout and of what is afforded to an organism within that layout. Perceptions such as those involved in walking may be delivered by pick up from the optical flow alone whereas abilities and dispositions of an organism are tied to the pick up of affordances from the environment.

On the ecological approach perceptual information is picked up by the sensory systems to reveal invariant structure. A description of this invariant structure refers in part to the environment and in part to the perceiver. The invariant structure is information for perception because it specifies its source in the environment. Information is not open to transduction in any sense.

Perceptual content on the ecological approach is delivered by the invariants and affordances. Perceptual invariants determine what is available to be perceived in a given environment at a given time. Different organisms have different structures and may pick up different invariants for different invariants may be available to them. The invariants are determined and individuated within the optic flow. Affordances are given in virtue of these invariants and are liable to similar constraints. Invariants and affordances are informative and

this information is the perceptual content that may be grasped by a perceiver. This is achieved through the reciprocal relationship of resonance between the animal and environment.

There is no unidirectional causation nor any information processing in perception. There are ecological laws relating organisms to the affordances of the environment. The theory of affordances provides a framework for the precise formulation and testing of hypotheses about these laws through the investigation of behaviour and perception. This suggests a way to integrate the phenomenological and mechanistic aspects of perception and perceivers without adopting either point of view at the expense of the other.

The ecological approach has an intentional and modulatory theory of behaviour where behaviour controls and adjusts. Behaviour varies as a function of the ecological situation and changes the situation to achieve the ends of the animal. Behaviour is reciprocally related to the ecosystem, see J.J. Gibson, "Notes for a Tentative Redefinition of Behavior", 1975, in RFR.

The ecological approach offers a solution to how perceptual knowledge and consequently all natural knowledge is possible by demonstrating that there is a comprehensibility and meaningfulness to nature that can be related to the capacities and ways of life of the knower.

Gibson approach embodies a naturalistic, ecological and evolutionary emphasis and this fundamental theme can be tied to the dynamic open system revolution in the biological and natural sciences. The role of evolution and ecology distinguishes the ecological approach from many common philosophical views.

One particular issue of concern is the ecological doctrine of direct perception. Critics argue that perception is necessarily a causal sequential chain involving psychological contributions and organisational processes. Within the context of this understanding of nature and scientific explanation perception cannot be direct. The philosophical context of such arguments is not commensurate with the ecological approach.

There is widespread agreement that Gibson's rejection of an elementaristic description of stimulation was a significant theoretical advance. The ecological approach goes far beyond this. The novelty of the ecological approach lies with its account of the dynamic relationship between the perceiver and the environment. This relationship is reciprocal resonance.

The notions of ecological reciprocity and of ecological resonance are crucial to understanding the ecological approach. These areas are often overlooked by commentators and critics. There is a tendency is

theorists to stick to a causal chain model which fits conceptually with a dualistic ontology that separates mind and matter. The ecological approach is set against such a model and does not sit well with analyses in such terms.

The ecological approach avoids dualism as it shows how the analysis of perception in terms of awareness and the analysis in terms of the physical world are different analyses of the same thing. Perception is not a two term causal relation from environment to perceiver but is a one term resonant relation between environment and perceiver which historically has been approached in two different ways. This historical approach has led to many misconceptions about the nature of perception.

The ecological approach avoids materialism and does not fall into mysticism by the ecological analysis of perceptual experience and the physical world joined in a reciprocal relationship involving a direct dynamicism. In this way he intended to find a way of avoiding mind-body dualism. The ecological approach challenges dualism in general and the epistemology of indirect perception in particular. It presents a direct realist philosophy of perception. Ecological reciprocity avoids both the absolute philosophical dichotomies of dualism and the one sided treatment of reality of philosophical monism.

The ecological approach avoids over-reduction with the doctrine of ecological reciprocity. The reciprocal complementarity of the views of perceptual experience and the physical world entails that they are not equivalents and therefore one cannot be identified with the other.

With perception there is a psychological change and a physical change so the ecological approach requires supervenience without reduction. This is achieved with the notion of ecological reciprocity. The ecological approach does not reduce the psychological to the physical.

The view of the ecological approach may be illustrated using an analogy with a hand of bridge. In a game of bridge I may take a trick. Here there is a physical change. The account and explanation of this change in physical terms does not explain the phenomenon of taking a trick. What constitutes the explanation here is the description and account of the relationships between the four hands. This in turn is explained by the rules of bridge. The rules and the relationships supervene on the physical but do not reduce to it. Furthermore, an elementaristic analysis of the cards and the players does not advance our understanding nor add to our explanation of bridge.

Seeing an object supervenes on the physical description of the object and the perceiver. Reciprocity blocks any reduction as the case depends on the relationship between the physical atomic

explanation but is not explained by it. The explanation required makes reference to ecological laws in reciprocal terms. In this way the physical connections and investigations of perception are shown to neither prevent nor disprove ecological direct perception.

The ecological approach treats perception as an ecological phenomenon rather than as a mental or physiological event. Ecological direct realism follows from the ecological definition of perception. This holds that perception does not reside in the brain or the mind any more than life resides in cells or in some inexplicable life force or spirit and therefore neither mentalism nor physicalism are correct. Perception is ecological. Perception exists at the reciprocal interface of animal and environment within an ecosystem.

The ecological approach puts spatial and temporal order back into the environment of matter and energy. The structures and capacities of animals are described relative to their ways of life within an environment. In turn the environment is described relative to the ways of life of animals. An explanation of perception involved a dynamic interdependency of animal and environment. Ecological epistemology runs on direct realism. The proper object of perception is the real world and, in particular, the perceptual environment.

The ecological approach distinguishes information in the environment from knowledge of the perceiver. Perceptual knowledge is the knowledge gained by the perceiver from the pick up of information in the environment, in other words it is that knowledge gained simply from the perception itself. This knowledge is direct and non-inferential. Perceptual knowledge may be used in making inferences. Once picked up perceptual information is open to processing by the action of the other cognitive faculties.

In common with many views, held by many thinkers, the ecological approach holds that an account of perception should be able to explain all kinds of perception and not just human vision. The ecological approach is not an ecological or environment involving version of any other common approach. Ecological invariants are similar to computational constraints which give a unique solution to a problem. The concept of resonance covers the ground opened up by the idea that the rules of perception are to be incorporated directly into the anatomy of the visual system by evolution and ecological circumstances. Creatures that resonated with the environment in this way evolved, adapted and survived better in a particular environment than some of those that did not.

Adopting an ecological, evolution sensitive, approach enables an account of perception to be given for all organisms. The ecological approach addresses perceivers as organisms in environments. It allows the distinction to be made between social and non-social animals.

The goal of the ecological approach is to put knowings on the same metaphysical level as anatomical and biological characteristics. The psychological states of an animal, like its anatomical features, are facts of the environment taken with reference to the animal.

Chapter Eight: Metaphysics and Realism

Metaphysical issues about perception split into two main areas. Ontological issues concern the description and explanation of perception whereas epistemological issues give the account and explanation of perceptual knowledge.

The ecological approach goes beyond perception in accounting for what is psychological and for what constitutes a psychological explanation. It possesses its own ecological philosophy with its own ontology and epistemology.

Ontology and the Ecology Approach

Ontological issues relate to what perception is about, in particular what is perceived and what is involved in perception. For the ecological approach this centres on the description and role of the perceptual environment which is equated with the ambient environment.

Ecological ontology is delivered by the understanding of the animal, the environment and the relationship between the two. The central ontological prop of the ecological approach is the principle of the reciprocity between perceiver and the perceptual environment, that is between distinguishable yet mutually supportive realities.

Ecological ontology is both materialist and dynamic. The ecological approach to perceiving and acting is materialist for nothing exists but matter and perceiving and acting are wholly attributable to material agency. It is dynamic insofar as things are continually changing. The ecological approach is, however, neither materialist nor reductionist in any eliminativist sense. The ecological approach attacks the reductionistic ontology of atomic physics arguing that every level of nature, not just the smallest, is real.

According to the ecological view, every change is the transformation of something and everything is undergoing change. There are no changeless things and there are no thingless changes. In short there are only changing things.

The ecological approach rejects the physicalist thesis that the only realities are physical systems of the kind made familiar in the various forms of mechanics and instead holds the view that material existing at every scale such as living systems and the ecosystems to which they belong, is all equally as real and concrete.

The theoretical shift brought about by the ecological approach marks an attempt to unite apparently different ontological realms. The ecological approach rejects any real separation between the artificial

and natural worlds, viewing nature in many ways such that all natural units and relationships are equally real and co-existent.

According to ecological ontology space and time are not absolute nor are they autonomous. They do not constitute space-time in that they do not form a self-existing container within which all things exist.

The ecological approach disposes of the notion of perception as a series of perceivings of discrete time slices. It claims that perception is not limited to a present instant as captured by a retinal snap shot. The information or stimulus for vision is rather held in the transforming optic array which surrounds the perceiver.

Time is not an arbitrary series of nows but is organised into naturally occurring events of varying duration. The transforming array is an optical flow or transpiring event which varies in duration compare, for example, a falling apple with a football match. The duration of the event is determined by its nature. This is a case of ecological compatibility.

Time is nonetheless an important part of ecological ontology for affordances refer to uses or movements involving animals and the environment. An affordance exists as a potential for an interaction between animal and environment. It is the animal which acts but it acts through the utilisation of an affordance.

On the ecological approach space and time do not constitute the elementary substance from which all else is composed. From these general points follows the elaboration of the ontological themes of the ecological approach. This gives the negative account of ecological ontology which states that,

- 1) There are no spaceless things and reciprocally there are no thingless spaces (vacuum being the absence of space), and,
- 2) There are no durationless things and reciprocally there are no thingless durations.

The positive account of ecological ontology holds that space and time are relations among facts. Space is made up from things namely the mutual separations and the mutual nestings of things. Time is made up from changing things, that is the mutual sequencing of changing things and the mutual nestings of changing things. Thus the ecological approach avoids the terms "space" and "time" for they denote absolute empty dimensions.

In ecological terms temporal relationships are embodied in relationships between particular surfaces. The ecological approach constructs the notions of space and of time from ecological realities, to be precise, out of the layout of terrestrial surfaces and the

embedding of terrestrial events. Standard references to space and time, in ordinary language, in mathematical terms and in physical theories, are elliptical references to facts, for by Gibson's lights;

"the reality underlying the dimension of time is the sequential order of events, and the realities underlying the dimensions of space is the adjacent order of objects or surface parts. ... time and space are not empty receptacles to be filled; instead they, are simply the ghosts of events and surfaces."

- EAVP, p. 101.

This relational view is to be taken further. Ecological ontology assumes that there are only changing things hence both space and time in ecological ontology are based in the notion of changing thing. It does not however include the redundant implication that changing thing is more a fundamental notion than space and time. With regard to the notion of space the mutual separations and nestings of things are not fixed but change continuously, given that there are only changing things. Space is therefore dynamic.

That space is dynamic is essential for the theory of the ecological approach as it allows for perceptual flow in general and for optic flow transformation in particular. Among its further implications are the ontological hypotheses that an affordance of surface layout need not endure and that new affordances of surface layout can come into existence.

Issues involving ontology and measurement focus on how space and time are endowed with metrics. In rejecting the absolute view of space and time in favour of the relational view we discard universal metres and absolute units. Such a dismissal has the following consequences,

- a) The states of any propertied thing are relative to a frame of reference.
- b) All reference frames are local.
- c) All units are relative.

Events too are the significant units of the world for perception. They are to be accounted for in a way that preserves their integrity in both time and space. Thus information like the events it specifies lasts over time and endures in the transforming optic array. As the optic array endures in space, so does the information of the optic array. Information both lasts over time and endures in space.

Perception, as the detection of information, lasts over time and endures in space. We can perceive the beginning of an event at a

later time as new information referring to that event may become available over time. A whole event is perceived not by adding parts but by detecting the continuity of those parts. These ideas provides an ontological anchorage for ecological perception. They cast perception as an ongoing activity of knowing the environment rather than as a collection of isolated results readied for processing.

Ecological perception asserts the primacy of events in perception. It divides the environment into space and time, time being further divided into moments. Ecological perception holds that the distinctions between past, present, and future are the product of introspecting on nowness. In this the temporal element of an event is fixed to a particular phenomenal experience. Perceivers have experiences of nowness but these give no premises for an argument to knowledge of past, present and future. Neither the perception itself nor the information whose detection is perception are limited to an instantaneous present. Both can be independent of any impression of nowness and independent of any particular experience.

Ecological ontology may be defined as the study of generic and hence non-specific features of the real environment. With this definition we may investigate the ontological basis of affordances. The theory of affordances constitutes a functional analysis of the environment. It is tied to structural-compositional ecology at one end and to the ecological theory of animals at the other. Affordances are neither phenomenal or mental qualities nor are they physical qualities but are ecological facts pertaining to the animal-related functions of the environment. Each basic feature of the environment, that is surfaces, edges, objects, media, events, substances and animate objects, possesses affordances, see J.J. Gibson, "A Preliminary Description and Classification of Affordances", 1971, in RFR.

The affordances of the ecological approach pertain to environmental features such as a solid surface that may be walked upon and make reference to animals and their capabilities. The geometry and composition of the environment support affordances where for example the ground is both flat and solid enough to allow for the terrestrial locomotion of animals. The supportability of the ground only extends for creatures up to a certain size. Affordances are not intrinsic, independent and absolute but are relational and reciprocal to the animal.

Though affordances are reciprocal to the structural and functional features of an animal, they are not subjective or contingent upon the moods or needs of the animal. They are relational properties of the environment and exist as opportunities, whether or not an animal wishes to use them, see J. Sanders, "An Ontology of Affordances", Ecological Psychology, 1997.

Ecological ontology involves substances, media, surfaces, events, invariants, affordances, information and perceivers. This ontology makes reference to animate life. Time is integrated into ecological space and ecological space is dynamic. Such an ontology supports the ecological philosophy of perception and the views of the ecological philosophy of mind.

Epistemology in the Ecological Approach

Epistemology is the branch of philosophy concerned with the theory of knowledge. It concerns the nature and the reliability of knowledge. One must suppose that for actions to be appropriate that knowledge is at least pragmatically correct. The epistemologist lays a basis for behaviour in correct knowledge about the world. To the question of how to ensure the correspondence of knowledge and reality philosophy has usually called on the resources of reason and experience. Rationalism holds knowledge that is true to the world is derived chiefly through reason rather than sense experience. By contrast empiricism holds that knowledge rests ultimately and necessarily upon sense experience.

Perception enters into the problems of epistemology when we try to develop a methodical explanation of it. Perception is integral to the study of knowledge and to science itself. Explanations of perception often take the form of separating perceptual awareness from the natural world throwing into question the possibility of knowledge about our surrounding environment. Explanations of perception commonly lead to the conclusion that we are caught up in an inner world of mental states and knowledge of the external world is problematic if not impossible.

The ecological approach faces two particular difficulties with the problem of knowledge as posed by commonplace epistemology,

- 1) Epistemology considers knowledge to be an entity inside an animal.
- 2) Insofar as reliability or truth is an issue, the epistemologist conceives of knowledge as propositions about the world.

The assumption that the basis for appropriate actions are things inside the head such as propositions, stands against the ecological position. The ecological approach is concerned with how behaving, rather than an hypothesised mental entity underneath it, might be appropriate to the facts of the environment. In addition the knowing or behaving is not considered to be propositional nor to be based on propositions and nor indeed to be based on anything else. To deny a propositional status to perception and action ultimately questions the appropriateness of terms such as "erroneous", "false", "incorrect" as qualifiers of actions and perceptions. The actuality of the facts of the

environment, so supported, provides grounds for the theory of ecological realism.

Epistemology makes claims about the knower and the conditions of knowledge. The epistemological part of the ecological approach stands in contrast with historically prevalent theories of perception. It involves an epistemological reformulation of perception and also of other forms of knowledge.

Something may exist without being known but if it is known to exist then it must exist. As the ecological approach shows if an animal is aware of something which does not exist then we are no longer concerned with perception or perceptual knowledge. The perceiver is not aware of itself simply by virtue of its existence. A perceiver must explore, test and be aware of itself, to know itself. Information about the self can be picked up but there is no necessity for it to occur. Nothing is known simply by virtue of its existence yet if it exists then there is information such that it can be known. Perceivers continually extend their abilities to detect information finding new ways to enhance and extend our perceptual awareness. Though knowledge and existence are distinguishable they are interdependent for what is known exists and what exists can be known. In this way knowledge and existence are ecological reciprocals.

Ecological epistemology resists the dualist idea that the relationship between things in the head and facts in the world is a legitimate avenue of inquiry. In this dualist sense knowledge, including perceptual knowledge, is an entity which underlies behaviour. The ecological approach holds the behavioural-knowledge entity to be mythical. On the ecological approach perceptual knowledge is part of the perceptions and actions themselves.

The position of the ecological approach on epistemology holds that the phenomena of knowing are to be understood through a holistic approach that acknowledges these phenomena exist in animal-environment systems and not merely in animals. Ecological psychology demands that both animal "who" and "how" terms and compatible environment "what" terms be included in an account of the phenomena exhibited by the system.

With regard to the environment the ecological approach offers extended treatments of events, occlusion, ecological substances, the medium, the opaque geometry of surface layout, the horizon, ecological ambience and affordances. The key to understanding how knowledge is possible is not just a description of the knower, but equally a description of the known for knowledge involves a reciprocity of knower and known.

Epistemologically the ecological approach is a direct realist one for it makes no appeal to sensory intermediaries from which inferences

are made to the characteristics of the real world. It is in this sense a theory of direct perception. No appeal is made to representations.

Perception does not involve an epistemic relation to anything from which inferences to the perception are then made. Perception is the information about the world which we pick up through the senses thanks to the perceptual systems. The pick up is direct pick up. In this way the ecological account of epistemology embraces ecological realism.

A major problem for epistemology is identifying that which ensures that knowledge and reality correspond. This correspondence is usually equated with the truth of the knowledge and its basis is usually sought in reason and sense experience. The ecological position while considering encounters with the environment to be the necessary basis for knowledge, appeals to a more general principle that the co-existence of things evidences their mutual compatibility. This position denies a propositional status to psychological attitudes and considers them as states of affairs that either exist or cease to exist according to natural selection. Those psychological attitudes manifested in actions must be compatible with the affordance of the environment. Evolution is compatible with animals in environmental niche and for psychology it is compatible with knowledge and facts.

The direct realist epistemology of the ecological approach runs on the notion of animal-environment reciprocity. This is an ecological reciprocity based on evolutionary considerations. This incorporates philosophical and psychological explanations of perception and behaviour with the notion of ecological reciprocity and rejects the causal chain explanation of perception.

Epistemological issues are met by the ecological approach principally through the development of the concept of affordances and by the ecological demand for realism in perception. For instance the epistemological questions stemming from ecological ontology require an account of how an affordance may be perceived as such over the wide variety of circumstances in which it is encountered. This is the issue of affordance constancy. Restrictions on the ordinary but subtle manoeuvres of inspecting a surface layout may impair affordance constancy. For example fixing the posture of the head or imposing demands on upright stance may be sufficient to render inaccurate, that is more variable, an observer's perceptions of sittable-on. Such observations are accounted for by the dynamicist nature of the ecological perspective. Whatever is perceived unchangingly is perceived as relative to or subject to a specific set of transformations, see L. Mark, J. Balliett, K. Craver, S. Douglas, and T. Fox, in "What an Actor Must do in Order to Perceive the Affordance for Sitting", *Ecological Psychology*, 2, 1990, pp. 325 to 366.

Though the distinction between what exists and what is known needs to be maintained or else the philosophical position will collapse to phenomenalism or to idealism, ecological direct realism implies that what exists are the actual objects of perceptual awareness. If the objects of knowledge are separated from the objects of existence then the result is a duality of mental objects and physical objects and ontologically indirect perception.

The dilemma is resolved by the principle of ecological reciprocity. Because of this notion of perceptual information, what exists possesses the potential to be known though it may not be known. The perceiver, as what knows, possesses the capacity to know because it is sensitive to this information. Furthermore, the perceiver is not an entity ontologically distinct from environmental objects of knowledge, insofar as both perceiver and environment are parts of the ecosystem and one perceiver can be part of the environment of another perceiver. The fundamental support for the knowability of what exists in the ecosystem are affordances which are specified by information. Affordances and information exist regardless of whether there is perception but if the perceiver explores and if its perceptual systems extract invariants from the environmental structure then it will be aware of itself and of environmental affordances. In this way ecological ontology and ecological epistemology are linked reciprocally in a way that is explanatory for perception and mind.

Ecological Realism

Ecological realism is based on the doctrine of external relations. This asserts that no object is essentially changed by its participation in a whole. Individual identity is an objective rather than a subjective property. Though causal relations between objects may change their relations to other objects, the identity of an object is not compromised by such relations. Ecological realism goes beyond this embracing Gibson's notion of naive realism and implying ecological direct perception.

On the ecological approach reality is holistic as opposed to discrete and nested as opposed to separated. This goes hand in hand with Gibson's view of naive realism which holds that we are acquainted with real objects in the environment that are in reality not importantly different from the way we normally perceive them.

The traditional philosophic notion of naive realism was well expressed by Bertrand Russell. Indeed he seems to have had some sympathy with just such a view:

"We all start from naive realism, that is the doctrine that things are what they seem. We think that grass is green, that stones are hard and that snow is cold. But physics assures us that the greenness of the grass, the hardness of the stones, and the coldness of the snow

are not the greenness, hardness, and coldness that we know in our own experience, but something very different. The observer, when he seems to himself to be observing a stone is really, if physics is to be believed, observing the effects of the stone upon himself."

- B. Russell, My Philosophical Development, 1959.

The ecological approach offers a far more sophisticated realism than this providing an ecological realism in general and an account of perceptual realism in particular. Gibson made the following epistemological claims for ecological realism:

- a) That what epistemologists have been trying to justify in *de jure* epistemology need not be justified at all, and
- b) That he has demonstrated that a perceptual psychology which applies the ecological epistemological viewpoint seriously will succeed in explaining many psychological problems.

This epistemological perspective avoids the more common difficulties with psychology and realism. It urges us to replace one set of *de jure* questions with another more tractable set. That the success of this approach is well evidenced by ecological psychology has strong implications for philosophy, see J.J. Gibson, "New Reasons for Realism", *Synthese*, 17, 1967, pp. 162 to 172.

The account of ecological realism begins with a description of the ecological environment. It is what this ecological environment affords for the perceiver that ecological realism aims to describe. The account depends to some extent on the phenomenological description of how such affordances make perceptual pick up possible. Thus the central tenets of ecological realism hold that:

- 1) What is perceived is the environment,
- 2) There is no dualism of mind and body or of the mental and the physical,
- 3) The concept of sensation is not to be used in an account of perception,
- 4) We do not infer perceptions of the world by information processing but confront it directly in a way that is meaningful to us, and that
- 5) Misperceptions are due to dysfunctions of the perceptual pick up system. Perceptual information is available to pick up systems in virtue of the environment. Misperceptions are marginal cases in the rich and complex world of perception.

These tenets deliver ecological realism and enable ecological perception to be direct perception.

Ecological realism sets out the relationship between the environment and the information present in the environment. This asserts that for visual perception there is enough information in the ambient light to specify the perceived characteristics of the environment completely. No supplementary information is needed. This applies to an observer who is free to move, free for example to orient the head. It is not difficult to deceive an eye when it is restricted to a single station point, that is to counterfeit an environment by creating a facsimile stationary array. This is done in many familiar laboratory demonstrations such as the auto-kinetic illusion. This may be described in the following way: In normal everyday conditions, a free moving observer is rarely deceived by perception.

Connected to this is the relationship between the optic array and the environment. That some components rather than others in the structure of the optic array, that is the nested set of solid visual angles, are aggregated in the way that they are is one consequence of this realism. Similar relationships hold for other perceptual arrays. In this way ecological realism is guaranteed by the objective structure of the world, see M. Henle, "On Naive Realism", in R. MacLeod and H. Pick (editors), *Perception*, 1974.

Ecological realism is supported with arguments based on the fact that an increase of available information normally leads to a more accurate perception of the environment. As observers move about sampling the spatio-temporal structure of the optic array in more and more detail, they come to see the real characteristics of their environment with increasing accuracy. Practical experience suggests that the obtainable degree of accuracy is very high. Thus for empirical purposes, the ecological approach is shown to be a very suitable account of perception.

Ecological realism endorses the theory of ecological information as specification for what specifies the perception of a perceiver is largely a matter of the perceptual properties present in the environment. The rest is down to the perceiver in question. A perception is specified by the perceptual information picked up from the environment which in turn is a property of that environment.

The view of perceptual information stimulation as impoverished contributes greatly to indirect theories of perception. This impoverished view of stimulation coupled with the organisational theory of the mind reflect a commitment to mind-matter dualism. Gibson in his development of ecological optics was obliged to redescribe and reconceptualise the environment to the extent that on the ecological approach it makes sense to say that the environment is perceived.

Within the context of an ontology of mechanistic causality and physical objects in space it is difficult to understand how an environment such as the ecological environment could be directly perceived. From an ecological point of view, however, the determination of perception between environment and perceiver is mutual. Ecological philosophy holds perception to be a function of this mutuality and thus it involves both environment and perceiver. Ecological realism is, therefore, compatible with ecological ontology.

Ecological realism is intimately tied to ecological direct perception. This involves the argument that since the specifying information is fully available in the ambient light then a perceiver need not do anything to it. This means that there is no processing in perception. Consequently, what is needed is not a theory of what happens inside the organism during perception at all. What is needed is ecological optics.

Ecological realism gives the grounds for the sort of realist account that is sometimes associated with the common sense view of perception and ordinary language philosophy exemplified by G.E. Moore and J.L. Austin, see G.E. Moore, *Philosophical Studies*, 1922, and J.L. Austin, *Sense And Sensibilia*, 1962. Neither perspective owes much to the scientific considerations that influenced experimental psychophysics or computational considerations in general.

Wilfrid Sellars and David Armstrong developed realist philosophies that are more sensitive to scientific ideas. Sellars advocates only epistemological directness with no inferential step while retaining an ontological separation of perception and the world, see W. Sellars, "Empiricism and the Philosophy of Mind", in H. Feigl and M. Scriven (editors), *Minnesota Studies in the Philosophy of Science*, I, 1956. Armstrong avoids Sellars's ontological dualism by adopting directness together with a materialist realism, see D. Armstrong, *Perception and the Physical World*, 1961.

Within scientific theories of perception the only alternative to indirect realist positions had been behaviourism. Behaviourism however reduces perception to associations between stimuli and responses. Ecological realism is a unique position.

Chapter Nine: Ecological Direct Perception

Ecological direct perception holds that perception is a straightforward function between environment and perceiver. This involves a relationship between the perceiver and the environment which may be analysed in terms of particular aspects of the environment and some patterns of the visual array such as higher order invariants, and in more traditional terms such as stimuli and percepts. Perception of objects as objects requires further explanation provided by the doctrine of affordances.

The term "direct" has a particular meaning in the ecological approach. One thing it means is that perception does not require a stage of sensory elements and sensations. The ecological account fills out this description with the explanation that the nervous system resonates with the available information in a reciprocal relationship so as to yield perception. What we are meant to understand by the term "direct perception" is something often called the "common sense" view.

The common sense view holds that if, for example, I see a dog, *I see the dog* and there is an end to the matter. We may add that conditions are normal and there is nothing wrong with me. This is a perfectly reasonable bare bones description. However it explains nothing about perception and neither adds to nor subtracts from the ecological approach.

The positive account of ecological direct perception has at its core the idea that only an account based on the pick up of information can possibly explain perception. That ecological perception is direct means that the environment can be directly perceived. Perception need not be supplemented by concepts or inferences or material stored in long term memory and that all theories which propose the use of such items cannot give a correct general account of perception. On the ecological approach whatever we take to be perceptual information need not be processed or filtered or collated or reconstructed. A perceiver need only to pick up the information that is already available in the optic array. This information specifies the real environment uniquely, unmediatedly and directly.

Ecological perception is both immediate and direct for the following reasons:

- a) The information that is picked up is structured so that it carries information about the environment. The senses are perceptual systems enabling the perceiver to interact with the environment in this way. The perceptual information picked up is such that the subject perceives things distinct from the perceiver. Perceptual information concerns the basic features of objects such as their

underlying states, whether they are rigid or non-rigid, the texture of their surfaces, their boundaries and their relative positions.

- b) This information is picked up directly by the perceiver. This means that the perception of such features does not require a sensation to be followed by and completed by an intellectual activity such as association or unconscious inference.
- c) Perception is direct because the subject is directly distinguished by its contrast with the objective. Each is perceived directly in contrast to the other. The subjective is distinguished from the objective directly.

On the ecological approach perception is direct and unmediated. Perception is mediated neither by memory nor by inference nor by any psychological process at all that deploys mental representation. This does not deny a relationship between perception and memory or between perception and inference. It does deny that either memory or inference or processing or indirect cognition is necessary for perception. It makes a total separation between perception and mental representation in any form. As such the ecological approach opposes all descriptions of perception involving mental acts, such as recognition, interpretation, inference, and combination with concepts, ideas or soul stuff. This presents us with negative reasons for accepting an ecological account of direct perception.

On the ecological approach information in the forms of invariants and affordances are picked up directly. Gibson offers two arguments as to why we can accept abstract information rather than spatio-temporal distribution of light energy as what is picked up directly.

The first turns on the relationship between sensation and perception. The direct theory holds that the sensation based view is false and that immediate perception of abstract information follows. If the sensation based view is false and if the direct perception view is correct then it must be that abstract information is picked up.

Gibson's second argument for the existence and direct pick up of abstract information holds that the distribution of patterns of light in space and in time are directly available to the perceptual system.

These together show that the notion of abstract information for perception is implied not by the rejection of the sensation based view of perception but by the acceptance of the theory of direct perception.

Ecological direct perception emphasises the relation between the environment and the optic array. Experimental research in this area supports theories of ecological optics which describe the information available to be picked up and the way this information specifies the

environment. The relationship between perceiver and this environment is accounted for by the pick up of this information. This is an activity which requires no processing of any sort on the part of the perceiver.

Ecological direct perception accounts for the detection of invariants as the attunement of perceivers to higher order patterns within a sea of information. This is the basis of perceptual awareness. This is illustrated by diagrams of a perceiver surrounded by an environment filled with lines indicating perceptual flow. This delivers the directness and the realism of the ecological approach.

Affordances are perceived directly. They may be grasped without synthesis or analysis. The properties of objects which reveal them as graspable affordances are perceived directly from the pattern of the visible optical array. All information specifying affordances is represented in the patterns of reflected light. It is not represented mentally. This theory shows up in the nature of affordances which for humans include surfaces that may be stood or sat on, objects that may be grasped or thrown and substances that may be poured.

Ecological directness in the ecological approach means that the structure of environmental objects and events as they relate to a behaving animal is preserved in the energy patterns of the ambient environment surrounding the animal. The converse of this view holds that the structure of environmental objects and events is lost in the light or at the receptor surface or in the stimulation and must be restored in some way usually said to be provided by the brain. This converse view is not acceptable as ecological theory.

One of the main pieces of support for ecological direct perception is the premise that the success or otherwise of the behaviour of an organism bears witness to the scope and accuracy of its perception of its environment.

The flourishing of a particular organism indicates extensive knowledge of the environment of the organism achieved as a result of the perceptions of that organism. Organisms perceive their surroundings sufficiently well to guide discriminating actions such as avoiding collisions and gathering food. Thus a theory of perception is a theory of how and to what extent the environment is known. In this way ecological direct perception recognises the richness of perceptual experience and holds the basis of this to be in the richness of the environmental information and not in the elaboration of perceptual information.

According to the ecological approach while all animals perceive the environment directly, social animals can also perceive the environment indirectly. On the ecological view representations are

the results of processes of information selection and display that serve to make perceivers aware of something.

On the ecological approach a distinction should be,

"made between perceptual cognition, or knowledge of the environment, and symbolic cognition, or knowledge *about* the environment. The former is a direct response to things based on stimulus information, the latter is an indirect response to things based on stimulus sources produced by another human individual."

- SCPS, p. 91.

We live in a shared environment but theories of sensation based perception cannot help us to understand the sharing of awareness. You and I can never have the same sensation because sensation is by definition an internal and momentary process. In contrast your perception and mine can be identical even though your sensation and mine can never be identical at the same time. The same invariants over time are available to us both. Information is external, available and ambient. It is not internal. Not only is information external. This also specifies both the self and the environment.

On this argument the ecological approach is to be favoured for its directness. This shows up in two ways:

- 1) All of the information specifying environmental structures and events is directly available to the perceiver.
- 2) Perception is the unmediated utilisation that is the direct pick up of this information by an animal co-ordinating its activities with the environment. The role of activity has an ecological character in contrast to the use of the term "description" which is linked to the notion of an affordance.

These two points are interdependent. That the information for perception is directly available in the environment indicates that the function of perception is to acquire this information. The ecological approach does not claim that directness is the lowest level of description of things to do with or things connected to perception. It claims that a direct description is the correct description of visual perception.

The ecological notion of directness opposes many commonplace ideas of philosophy and psychology. In particular, it opposes the following ideas:

- a) Perceptions of the world are caused by stimuli.

- b) Perceptions of the world are caused when sensations triggered by stimuli are supplemented by memories.
- c) A sequence of stimuli is converted into a phenomenal scene by memory. Here the notion of stimulation as composed of discrete stimuli is to be rejected for ecological perception is based on continuities and not on discrete episodes.
- d) Exteroception and proprioception arise when exteroceptors and proprioceptors are stimulated with insufficient information.
- e) The belief of empiricists that the perceived meanings and values of things are supplied from the past experience of the observer.
- f) The belief of nativists that meanings and values are supplied from the past experience of the race by way of innate ideas.
- g) The theory that the inputs of the sensory channels are subject to cognitive processing. The inputs are described in terms of information theory but the processes are described in terms of mental acts such as recognition, interpretation, inference, concepts, ideas and storage and retrieval of ideas.

These are the operations of the mind upon the deliverances of the senses. These ideas form no part of the ecological approach. The implications of this opposition are spelled out in the EAVP, and are supported by a close reading of selected experimental evidence.

Many philosophers have objected to the idea that perception is direct. Ecological direct perception avoids these objections precisely because it is ecological. Ecological direct perception is a wholly different definition of perception to those commonly presented. Ecological perception takes place in a system of organism and environment involving the detection of information. That ecological perception is direct means that perception itself is an active act rather than a passive triggered response and is to be judged as an achievement rather than as a reflex. Ecological perception is direct just because a perceiver perceives its environment.

Mediated Perception

There is an important difference between direct and indirect, and immediate and mediate. "We directly perceive the world" does not mean the same as "we immediately perceive the world". The distinction between direct and indirect concerns images such as photographs, drawings and television pictures whereas the distinction between immediate and mediate concerns instruments such as telescopes, microscopes and magnifying lenses. In this way we may contrast image with instrument, and realism with instrumentalism in an ecological way.

On the ecological approach for perception to be mediated is for it to be mediated by some part of the ecological environment such as the gaining of information about something through a telescope or a microscope, with spectacles or from a picture, a poem or a letter for,

"images, pictures, and written-on surfaces afford a special kind of knowledge that I call mediated or indirect, knowledge at second hand."

- EAVP, p. 42.

Furthermore, on the ecological approach there is no mediation through the stimulation of sensations.

"Stimulation by light and corresponding sensations of brightness are traditionally supposed to be the basis of visual perception. The inputs of the nerves are supposed to be the data on which the perceptual processes in the brain operate. But I make a quite different assumption, because the evidence suggests that stimuli as such contain no information, that brightness sensations are not elements of perception, and that inputs of the retina are not sensory elements on which the brain operates."

- EAVP, pp. 53 to 54.

Mediation in ecological perception is therefore nothing other than the gaining of perceptual information about something through a perceptual instrument or from a picture, writing or testimony.

Indirect Perception and Ecological Perception

Indirect perception claims that there is a difference between what is perceived and what is provided by the environment. A common version of indirect theory holds that only phenomenal individuals such as representations are directly perceivable.

Ecological direct perception claims that what is perceived is provided by the environment. Physical objects are directly perceivable. Perception of the ambient environment does not involve the perception of phenomenal individuals.

The view that perceivers and environments are mutually independent is embraced by indirect theories of perception in these three ways:

- 1) Perception involves the environment projecting into a matrix that constitutes part of the perceiver.
- 2) Perception requires processes of reason or cognition to be implemented by the neural make up of the perceiver.

3) Perception involves memory or knowledge of facts and rules both in general and in particular.

Taken together these three points give us an understanding of the surrounding environment of a suitable perceiver in terms of a theory of indirect perception.

The overarching presumption of indirect perception is the ontological and epistemological mutual independence of environment and perceiver. In this, the indirect, case point 1) gives a notion of detective mental processes, point 2) fosters a definition of the environment in both animal neutral and strictly physical terms, and point 3) discourages the pursuit of any notion of ecological invariants, affordances, and such like.

In contrast, ecological direct perception recognises and seeks to account for the full richness of perceptual experience in purely perceptual terms. The basis of this perceptual richness lies not in elaboration by cognitive processes but in the richness of perceptual information. It proposes a precise specification of the nature of objects, places and events available to the organism in the information.

Indirect perception takes as its starting point the idea that the input to the senses is inadequate. Where the input is based on retinal images or iconic memories thereof perception is recognised as:

- a) Imprecise, for there are distortions of size and shape,
- b) Impoverished, for the third dimension is absent, and
- c) Meaningless, for all discrete samples of time are meaningless without a context.

Thus, the task for the indirect theorist is to explain how this inadequate input is embellished, organised, structured and repaired so as to yield the perception enjoyed by normal perceivers in normal circumstances. This is a formidable project, as acknowledged by Marr and others, and, given the ecological approach, it is a totally unnecessary one, see D. Marr, Vision, 1982.

Indirect theorists point to the lack of neurophysiological explanations in the ecological approach. That perceptual resonance involves the neural make up of the perceiver is not disputed. It is the role of the neural make up of the perceiver that is at issue between the ecological direct and general indirect approaches to perception.

Ecological direct perception is challenged by the conceptual, indirect approach to perception of constructivist thinkers such as Richard Gregory. Gregory sets out the classic constructivist position, as

practised by mainstream experimental psychologists, in his *Concepts and Mechanisms of Perception*, 1974.

The success of the constructivist challenge to the ecological approach hangs on the ability of indirect accounts of perception to answer the questions, "where is the activity in perception?" and "what is the information in perception?".

On the ecological approach perception is an active, information seeking process of searching ambient arrays of energy for information about the surrounding environment. Gregory too claims to have an active theory of perception but the action is in a kind of thinking or problem solving process following after perception. Perception for him is a passive intake of whatever energy happens to fall on the receptors.

On the ecological approach the ambient array is rich in information that specifies layout, objects and events in the world. For constructivists like Gregory only slivers or hints of information are available to perception which must be supplemented by inference, piecing together the evidence with the aid of past experience like a detective. It needs something to do this inferring which suggests some form of homunculus. How the past experience, which must itself have begun as impoverished, becomes meaningful is one problem and has led some indirect theorists to the idea that everyday perceptions are imaginative constructions or fictions.

Taking up this point Gregory compares Gibson's approach to the behaviourism of B.F. Skinner implying that it is an elementaristic, one to one, stimulus-response position. This is not so. What the ecological approach stresses is the interleaving and inseparability of perception and action. A perceptual system incorporates actions such as head and eye movements in the visual system. Perception guides action and action informs perception. The study of perception and action as an inseparable system is a popular position, see R. Gregory, "Seeing as Thinking: An Active Theory of Perception", *Times Literary Supplement*, 1972.

Gregory stresses the inclusion of computer programmes in his account and the desirability of studying illusions rather than everyday behaviour such as guided locomotion. This implies that the ecological approach neglects the tough, internal problems of perception.

In their reply to Gregory the Gibsons state that, on the contrary, it is constructivism that gives up on the difficult problems of perception by dismissing the role of the environment and by claiming that all perceptual knowledge is self-constructed. In contrast, the ecological approach meets these problems head on by attempting to account for our remarkably veridical perceptual ability to deal with the

surfaces, substances, objects and events of the environment that we and other animals are obliged to cope with and use both as a species and as individuals. For the Gibsons, it is in virtue of our relations with the environment that we must perceive and this in order to behave successfully at all. Thus for perception to take place at all there must be information about what goes on in our environment and we must obtain this information in a current, here and now, direct form as we continuously move through and maintain our relations with the environment. Explaining how we do this forms the central part of Gibson's work on the ecological approach to visual perception, see E.J. Gibson and J.J. Gibson, "The Senses as Information-Seeking Systems", Times Literary Supplement, 1972.

Shimon Ullman and Direct Perception

Shimon Ullman defines direct perception as perception that does not involve computations of any sort. Ullman examines the notion of directness in the theory of perception. With respect to visual perception Ullman goes on to argue that the richness of stimuli and percepts prevents a satisfactory theory of a direct mapping between them, see S. Ullman, "Against Direct Perception", BBS, 3, 1980, pp. 373 to 415.

Ullman splits the ecological approach into three parts;

- i) the information content of the visual array,
- ii) the visual array and its relation to ecology, and
- iii) the immediate or unmediated direct approach to perception.

The parts concerning the information content of the visual array and its relation to ecology are accepted. The third part is the immediate or unmediated direct approach to perception. Ullman finds this to be lacking in certain respects. Ullman requires it to be extended by a more comprehensive theory drawing an integrated picture of the perceptual systems at the levels of function, process and mechanism. This involves composition and decomposition to be accounted for by computation in computational terms.

Ullman goes on to examine the notion of information pick up and its use as a primitive construct in the theory of perception. The immediate registration of information is seen by Ullman as the key to Gibson's direct theory. It is how the properties of objects are seen. Ullman questions what sort of stimuli can be registered directly and what sort of primitive operations can be assigned to the sense organs in the way specified by the ecological approach.

The substance of Ullman's case against direct perception is his consideration of how information, transformations and invariants can

be the direct stimuli for visual perception. According to Ullman, Gibson has two arguments as to why we can accept abstract information rather than spatio-temporal distribution of light energy, as the direct stimulus.

Ullman's first required argument for direct perception turns on the relationship between sensation and perception. According to Gibson, the sensation based view of perception is false and therefore immediate perception and abstract stimuli follow. Ullman however says that the actual position is that if the sensation based view is false and that if the immediate perception view is true then it is true that abstract stimuli are picked up. In this way the notion of abstract information as the stimulus for perception is implied not by the rejection of the sensation based view but by the acceptance of the theory of immediate perception.

Ullman states that the second argument required for a theory of direct perception is that for the existence of abstract stimuli and their registration. This holds that the distribution of patterns of light in space and in time are directly available to the perceptual system. For Ullman the key to the debate concerns the nature and complexity of the processes that register the information in the spatio-temporal patterns. This asks whether the registration of information is to be taken as a primitive construct or whether it has an explanation within the theory. The fact that spatio-temporal patterns of light carry sufficient information for visual perception does not itself entail the immediate registration of the information in these patterns. It is a question of whether meaningful decompositions are possible. If they are then the claim that the properties such as rigidity is picked up directly is not satisfactory. If so then explanations from the theory of direct perception should be regarded as a last resort rather than as a starting point for cognitive theories.

Ullman is no doubt correct to argue that theories of perception should attempt to explain the psychological processes involved in perceiving. His arguments against the ecological approach are however incorrect for Gibson did not hold that pick up is an unanalysable primitive construct. On the contrary, Gibson analysed and expounded the notion at some length.

Ullman assumes that direct perception implies a stimulus-response or psychophysical view of perception whereas the ecological approach involves neither a stimulus-response approach nor is it a psychophysical view of perception. Gibson expressed regret that many took him to have maintained such views when in fact he had been working hard to discard such an outlook from the 1950s onwards.

To demonstrate indirectness in perception Ullman attempts to show that the mapping between the stimulus and the percept is not one to

one. This would mean that constant changes internal to perceivers have an effect on perception. Ullman is unable to do this. Only in his assessment of Mach illusions does Ullman explicitly and empirically demonstrate that the perception of structure and motion might be a function of two variables. These variables are the incoming image and the current interpretation of the observer. This leaves room for the ecological direct explanation. There is no necessity for an indirect analysis.

Ecological direct perception does not involve the inversion of indirect theories but does rather reject their basic assumptions and hypotheses. Contrary to Ullman's account the ecological theory of perceptual activity is an attempt to explain how ecological information is detected by mechanisms of purposive attention. It does not involve mapping between stimuli and percepts.

The ecological approach rejects the hypothesis that the stimulation of receptors is the basis of perception. Ecological information exists within the environment in energy patterns which are relatively in space-time. It cannot be registered by a receptor. Information is too densely structured to be registered by a passive receptor surface. A pattern of peripheral stimulation cannot be ecological information because it cannot specify its environmental source. Gibson takes this to show that proximal stimulation is not the basis of perception. Information that is specific to its source is the basis of ecological perception.

Gibson offered a detailed analysis of pick up which led him to question the classical principles of sensory physiology. This anticipated the later efforts of neurophysiologists such as Luria. Gibson did not hold the view that perceiving involves the coupling of stimuli and percepts that Ullman ascribes to him. He held that perceiving occurs when animals attend to ecological information. He hypothesized scanning and attentional activities to explain how organisms detect information relevant to their behaviours and needs.

While information is picked up the mutual adjustments of the organs of a perceptual system require that neural excitation flows centrifugally, centripetally and horizontally as well as vertically throughout the central nervous system. This is not a demonstration of indirect perception for the visual system is not a channel for transmitting signals from the retina to the brain. It is a system for sampling the optic array. Indirect accounts deals with the vicissitudes of sensory signals in the afferent channels of passive systems. They ignore the activity of looking and the psychological functions which this activity serves. The ecological approach emphasises that learning, attention, anticipation, motivation and other psychosomatic factors modulate ecological information pick up.

Having offered his analysis of the ecological approach Ullman launches a general attack on direct perception arguing that the perceptual process is decomposable and that there is a complex physiology and psychology which underlies perception.

Gibson himself recognised the physiology underlying perception to be complex. The decisive question is whether the mechanism, however complex, somehow adds information in a perceptual process or whether it is a system of an organism involved in a relationship of reciprocal resonance with complete perceptual information residing in the surrounding environment. What makes ecological perception direct is that what is perceived is solely determined by the perceptual information picked up.

Ullman argues that what can be decomposed must be indirect, that processes such as computations can always be decomposed, that perception involves processes and thus that perception must be decompositional and therefore indirect.

Ecological direct perception does not deny that there are perceptual systems. Quite the reverse is true. Gibson devoted a whole book to them, namely the SCPS. The perceptual systems are undoubtedly transformed in some way by perceptual resonance since ecological information while it specifies what it is to be perceived is not like it. Ecological direct perception neither requires nor implies any denial of the anatomy of the nervous system and its functioning.

Perception is the direct pick up of information through higher order invariants and through affordances. It neither involves nor makes demands on mental representation or inference. Ecological direct perception is an assertion that in order to have a perception, a perceiver does not have to add information to the perceptual information picked up directly.

For Gibson the term "direct" refers to the notion that there is information available in ambient arrays of energy surrounding the perceiver that is sufficient to specify the sources such as the objects, events and layouts, in the world. This is information from the environment available and provided in accordance with the ecological account. This does not require supplementation by ready made concepts or by any other thing. There is no supplementation in what is direct and according to the ecological approach what is not direct is not perceptual.

The ecological approach shows that what is componential is not perceptual and that the physiological processes of the brain are not perceptual. Perception occurs to perceivers in environments, not to brains in heads, not to computers in robots and not to algorithms of functions. It focuses on the environment of the normal perceiver for perception gives the perceiver information about this environment. In

normal circumstances there is more than enough perceptual information available in the environment. This is shown by careful ecological analysis whereupon perception is a way of acquiring information directly.

An attack on direct perception should be concerned with the processes internal to the perceiver which might independently contribute to perception. It should also undertake a detailed examination of the information of the optic array itself asking whether it really can be self sufficient. Arguments and evidence for these points would provide a serious challenge to the ecological approach.

Chapter 10: Sensation and Perception

Sensation Based Theories of Perception

Though there is no widely agreed definition of sensation, sensation based theories of perception may be characterised by the following points:

- 1) In perceiving there is something between that interfaces or coordinates an animal with its environment. This something is variously referred to as ideas, representations, sense-data, propositions and percepts. This says that an animal is not directly acquainted with its environment but with a surrogate for that environment.
- 2) The perception of any particular object is predicated on the logically prior perception of particulars of a more elementary nature such as Ullman's set of semantically impoverished predicates of the senses that are translated into a set of semantically rich predicates.

Sensation based theories are commensurable with phenomenal individuals such as representations. Indirect perception comes to the claim that just and only such phenomenal individuals are directly perceivable. Direct perception thus consists of two claims, namely that,

- a) Physical objects are directly perceivable, and
- b) The perception of physical objects does not involve the perception of phenomenal individuals.

Sensation based theories are active only insofar as they are activated by stimuli. Further activities are postulated to supplement or to correct the sensory input. These supplements and corrections include interpretation, organisation, inference making, attachment of meaning, memory fusing, concept combination, logic imposition. These ideas have no place in the ecological approach to perception.

The debate between sensation based and information based approaches to perception centres on the differences between the roles of sensations and of information in perception.

It may be asserted that sensations are not specific to the environment and that perception is therefore a further mental process applied to sensory inputs. Gibson countered this claim by pointing out that if sensations are not specific to the environment then they cannot be the basis of perception. Instead, there must be some information specific to the environment on which veridical perception rests.

In sensation based theories perception is held to be a multi-stage process. This process is initiated when physical energies impinge on sensory surfaces which give rise to sensations. These sensations are subsequently transformed and enriched through a series of cognitive operations. The end product of these operations or processing stages is a percept of the environment. Enrichment of the input is considered necessary because the pattern of stimulation available at the receptors is taken to be equivocal with respect to its environmental source. Consequently the perceiver must supplement this input with other sensory or memory based data and must infer the character of the environment from these sources. Since the percept results from this series of processing or enrichment stages the perception of the environment is indirect. In this way such sensation based theories of perception commit themselves to philosophical indirect realism.

The ecological information based theory claims that perception of the environment is direct and does not require supplemental processes to enrich sensory input. Gibson argues that the structure of the environment is specified by ecological considerations. In the case of vision the structure of the environment is unequivocally specified in the reflected or ambient light that is the ambient optic array. Since the structure of the ambient optic array unequivocally specifies the environmental layout, any animal which is sensitive to that structure as a consequence of its phylogenetic and ontogenetic history is able to pick up this structure directly. Activities of the perceiver such as movements of the eyes, torso and head play a central role in this pick up for such actions induce transformations in the ambient array and thereby facilitate the detection of those structures invariant in it.

Sensation has no role in an ecological theory of perception. The ecological approach to perception is information based. It talks of activity that orientates the organs of perception, explores the ambient array and seeks an equilibrium. All this activity is independent of sensations. This activity marks out the perception itself by directly picking up information without the involvement of sensations. On the ecological approach perceptions are delivered complete in virtue of perceivers in their ecological environment.

On the ecological approach the ambient information at a location may remain constant though it is not the same as at any other location. As perceivers move through various locations so they are able to have the same perceptions. This involves external objects such as trees, parts of my body such as my hands, my perception of my nose and my sensations. My sensations are not my perceptions. Sensations are not perceptions. In this way the psychology of perception and the philosophy of perception show a new face when perception is considered at its own level distinct from that of sensation.

The ecological approach cuts against sensationalism at its very base. The lack of a position for sensation in the ecological account of perception leads the ecological approach to reject many well founded assumptions of traditional, non-ecological approaches to perception. This has led to some confusion among critics who assume that the ecological approach attacks only some tenets of the position rather than uprooting the whole of the sensation based approach.

The change from a sensation based to an information based theory of perception has implications for the account of our psychology. In the past our notions of knowledge, memory, expectation, meaning and the self have been derived from sensationalist premises. If sensationalism is rejected then many portions of psychological explanation in philosophy and psychology need to be revised.

Though Gibson focussed on perception it is to be emphasised that he was mindful of the broad implications of his thinking and produced papers for the reconstruction of the philosophy and psychology of mind. The necessity for reconstruction rests, from this viewpoint, on the reconsideration of the place of sensation. Whatever the true place of sensation it is not fundamental or foundational.

Once sensationalism is rejected then we do not need an account of how observers perceive a constant, solid, meaningful world on the basis of fleeting, tenuous and meaningless sensations for we do not perceive the persistent world on the basis of changing sensations. There are no meaningful problems relating to such an account for such a description is mistaken. What we should ask is how we perceive both persisting and changing properties of the environment on the basis of ecological information. This is explained by the ecological theory of environmental specificity with respect to perception.

The senses are commonly considered to be transducers of proximal sensory data which are converted into meaningful representations by memory, imagination and other intellectual processes. A dry sensation in the throat is not a motive to seek water unless and until it is incorporated into knowledge about thirst and liquids and it is related to prior experiences of being thirsty and of quenching one's thirst. In this way sensations may come to have motivating values as positive or negatives. This is driven either through reinforcement as in behaviourism or through hypothesis testing as in cognitivism. Motivation is thus added onto sensing. Once again awareness of the world is indirect. It is only by combining this indirect knowledge of external things with the more direct knowledge of positive or negative effects on ourselves that we become aware of the uses and values of things. The fire looks dangerous because we have come to

associate the sense inputs it gives rise to with our knowledge and experience of burning.

Against this view the ecological approach proposes that the senses are perceptual systems. They are a means of picking up information about the affordances of the environment. In this way perception itself is motivating. It is not passive-reactive. The sensation of dryness in the throat may or may not be relevant to the need to drink. The perception of water that affords drinking, which often occurs completely independently of the sensation of dryness, is in and of itself relevant to thirst.

On the ecological approach it is the animal that has sensations not the nerves. The senses are conduits conveying information about properties in the environment. Ecological theory rejects the notion of the senses as conduits because this assumes that they convey incoming messages. Indeed Gibson himself questioned whether there are nerves that can properly be called sensory.

The ecological approach conceives of the nervous system as operating by interacting reciprocally with the environment. Ecological information is not passed on once and for all but is extracted by the pick up of invariants over time. This information is available in the light, sound, chemicals and mechanical contacts that are part of the transforming array that surrounds the perceiver and that constitutes the flow of perceptual information. On the ecological approach there is no place for reflexes, sensations and of processes of the mind and of the brain in the account of perception.

In this way our awareness of the world and its values is direct. The fire looks dangerous because we can actually perceive that its heat and flames would burn us. We may have to learn to see such things yet this learning is not a process of associating a sensed fire and a sensed burning into a representation of a dangerous fire but is a matter of learning to pick up the information specifying the burning capacities of fires.

The ecological notion of perceptual systems whose exploratory activities are intrinsically motivating leads to a reassessment of how perception is related to other cognitive functions such as remembering, recognition, expectation and symbolic thought. The sensation based theory of perception implies that memory differs from perception on the basis of an awareness of the flow of time where the feeling of an instantaneous "now" is involved in a present sensation but not in a memory. This sensational reasoning has led to many trace theories of memory where the sense input is said to be impressed on the brain or mind and then stored to be re-aroused for use in interpreting later inputs. In this way the sensation based theories of perception can lead to absurdity. For example a heard tone is based on a physical sine wave defined as a frequency that is

a change over time. It is however not true that one must hear the tone of a tuning fork by storing earlier impressions to compare with later ones.

Notwithstanding the above many theorists tie themselves to the assumption that a succession must be converted into a simultaneity in order to be apprehended. Gibson suspected that it was the lure of the image as the basis of perception that led to such confusions and he pointed out that, given the existence of thought without images then there is thought without memories as well, see SCPS, p. 276.

On the ecological approach observers do not have to learn to construct representations of things or to associate sensations and representations with pleasurable outcomes. Though perception is automatic, observers have to learn to make use of the information that is available to them in ways that are relevant to their activities and needs.

Sensations and Ecology

The ecological approach holds perception to be both separate to sensation and free from sensation. Sensation may be considered to be the subjective pole of experience (with pure reason providing the objective pole) but it does not provide data or messages for perception. It neither forms the elements of perception nor is it the innate beginning of perception. It is rather the basis of experience of the external world. No notion of sensation is ever necessary to perception, no matter how it may enter into introspection about perception and may serve as the subject of certain experiments.

The ecological approach has no place for sensation in perception. The rejection of sensation based theories of perception is a result of his distinction between the proper object of perception and the proper object of sensation. Sensations are image-like and fall into a different category to perceptions, which by contrast are real-thing like. Sensations are not simpler versions of perceptions. Sensations are subjective and incidental to perceptions. Perceptions however cannot be purely subjective for this introduces the notion of dualism.

The only kind of perceptual activity admitted by the more common non-ecological accounts is mental activity in the form of operations of the mind upon the deliverances of the senses. The ecological approach rejects this. The activities that count ecologically are looking, listening, touching, sniffing and tasting. These are undertaken by the working perceptual system which involves the physical adjustment of organs and not the mere stimulation of receptors.

These activities are functional. They are not to be described as activities of the mind nor are they just physical. The pick up of

invariants over time involves the optimising activity of a system. In this way the ecological approach avoids the fallacies of mentalism and the fallacies of stimulus-response behaviourism.

Many common theories are sensation based and are only active insofar as they are activated by stimuli. Further activities are postulated to supplement or to correct the sensory input. These supplements and corrections variously include, interpretation, organisation, inference making, attachment of meaning, memory fusing, concept combination and logic imposition. These ideas have no place in the ecological approach to perception. The ecological approach talks of activity prior to sensations aroused by stimuli. This activity orients the organs of perception, explores the ambient array and seeks an equilibrium. These are independent of sensations.

Having sensations is not perceiving yet perceiving depends on the senses, insofar as it requires the operation of the sense organs as properly defined. On the ecological approach what is sensed is the optic flow. This can be described as a flow surrounding the perceiver governed by the laws of motion perspective. The perceiver is aware of the optic flow but not conscious of it.

The ecological approach rejects any mentalistic interpretation of perception by which the mind is held to be independent of the external world and populated with mental entities. The mind is a functional process of an ecologically integrated living form. Our minds are active though neither material nor substantial nor absolutely localised. They are not reducible to neurones, living cells or molecules. Some ecological theorists go so far as to claim that the mind itself is an ecological, evolutionary emergent, active form of a sentient animal.

Sense Data and Perception

An important motive for Gibson to formulate his theory of perception without sensations as intermediaries was his conviction of the falsity of the doctrine that what we perceive is our private sense data. For Gibson perception does not involve anything private, whether sensation or representation. To ensure this he gave an account of perception that was unmediated, world involving and left no room for mental operations and private data, see J.J. Gibson, "The Myth of Passive Perception", RFR, pp. 397 to 400.

There is a clear distinction between sensations and sense data. With the sensory mode of touch the experience of the texture of a surface seems to be mediated by sensations in our fingertips. This is in contrast to the visual mode where sensation is insufficient for an account of what it is to see an object for it is in the context of the experience that information about the object is obtained. This occurs

through the operation of the sense of vision as a system for obtaining such information.

With respect to sense data it is important to understand just what the ecological approach denies. The traditional argument for sense data asks us to consider what is in common between the case in which I perceive x and the case in which I have a hallucination which is in all respects just as if I were seeing x. There is something in common between these experiences and that thing is the sense datum, see G.E. Moore, "The Nature and Reality of Objects of Perception", Proceedings of the Aristotelian Society, 1905 to 1906. This includes an extended account of such issues.

Now, the ecological approach denies that there can be a case in which a perception and an hallucination can be the same in all respects. That there are no circumstances that are the same in all respects is shown in that there are different accounts for perception and for hallucination. Perception is ecological and hallucination is, by definition, non-ecological. There is, therefore, a qualitative difference between perceptions and hallucinations. Perception is direct cognition and hallucination, whatever else it may be, is indirect cognition. Given that perception is ecologically direct and that hallucinatory sensational objects are not there can be no occasion on which the perception and the hallucination are the same. To suppose otherwise is to be confused as to the ecological nature of perception.

To simply regard perceptual and sensational objects as concrete produces an ambiguity, for it ignores the hypothetical nature of turning sensory input into data. Such a hypothesis goes against all forms of direct realism including the ecological account of perception where the pick up of perceptual invariants is given in virtue of the surrounding environment. The ecological approach does not recognise the turning of sensory input into data and ignores any supposed hypothetical nature of this act. The ecological approach rejects the idea of such sense data outright.

The acceptance of a sense datum theory of perception may be equated with the view that perception involves inference. Direct realism may be equated with the view that perception does not involve inference. This alone does not prevent a sense-datum theorist from holding that perceptual knowledge is non-inferential. Sense data are supposed more respectable, more testable, because they are supposed to be connected to the outside world, to the environment. Sensations are like this. For instance, to feel a pin prick simply prick yourself with a pin. Ecological perception is not like this for the ecological approach has neither use nor place for sensations. Thus sense data even if given without inference still do not help to explain perception.

The ecological approach accounts for perception and perceptual awareness in a way that neither requires nor has room for sense data. There is nothing for a sense datum to do. Even if they can be shown to exist they are redundant for still they play no part in perception.

The ecological approach conceives of an animal and its environment as logically dependent. It presents an explanation of an animal and its environment as complementary systems acting acausally as reciprocal contexts of mutual complementation and mutual restraint. The animal term and the environment term need not, and probably do not, relate as a projection. The environment is not projected into the animal in any form. The animal is not projected into the environment in any way and in particular not by sense data. This is the point of the ecological approach. It can be shown in several ways.

J.L. Austin has attacked the argument favoured by some earlier philosophers that since we are sometimes deluded by illusions, such as a straight stick partly submerged in water, we see sense data rather than material things. Austin discusses the idea that perception tells us about real properties of the external world and considers the notion of real shape. In his discussion he accounts for the example of the tilted coin that looks elliptical, a case famously taken by Berkeley to show the reality of ideas and to deny the reality of the material:

"[The coin has] a real shape which remained unchanged. But coins in fact are rather special cases. For one thing their outlines are well defined and very highly stable, and for another, they have a known and a nameable shape. But there are plenty of things of which this is not true. What is the real shape of a cloud ? ... or of a cat ? Does its real shape change whenever it moves ? If not, in what posture is its real shape on display ? Furthermore, is its real shape such as to be fairly smooth outlines, or must it be finely enough serrated to take account of each hair ? It is pretty obvious that there is no answer to these questions - no rules according to which, no procedure by which, answers are to be determined."

- Sense and Sensibilia, 1962, p. 67.

By way of response to Austin, the ecological account holds that our normal perceptual activity runs correctly delivering a true description of what is there. Although thanks to evolution our perception allows for many changes the perturbation due to the refraction of light by water is not one of them. Though the example of the stick in water has been discussed since antiquity there has been little or no philosophical enquiry into the nature of the perception of a gannet say. This bird feeds off fish seen from above the water surface. For such birds a visual correction may be necessary and this too may be

accounted for by the ecological approach. It is the latter commonplace, ecological cases that allow us to explain the unusual, illusory case rather than any resort to theories of sense data, see D.N. Lee and P. Reddish, "Plummeting Gannets", *Nature*, 293, 1981.

Chapter Eleven: Concepts and Perception

Many theories of perception assume that perception is fundamentally concept involving. The ecological approach does not take this as an assumption and addresses this as a separate and distinct issue.

"The classical theories of perception assume that the flux of stimulation causes a flux of sensation, the basis of perception, and that the perception of permanent objects must somehow be constructed from this flux. One common explanation is that we have "concepts" [scare quotes] which enable us to interpret this sensory flux. (The concepts may be acquired or innate; that is controversial)."

- J.J. Gibson, "Note for a Tentative Definition of Behaviour", 1975, in RFR.

For Hume concepts acquired through experience can be used by the imagination to make a coherent world out of the flux of sensations. Jean Piaget argued that the activities of infants help them to create such concepts as that of persisting objects. Under the influence of Noam Chomsky many cognitive psychologists came to believe that such concepts are innate and are not acquired at all. All agree that some sort of concept must give rise to the coherence of the experienced world. Disagreement arises over the sort of world. Gibson objected to all such formulations for they all proceed from the false assumption that sensations must be the basis of perception,

"My hypothesis is that *lastingness* is *perceived* when the surface is concealed and revealed, although the longer the concealed interval between transitions the less *definite* is the percept. I argue that a "concept" (the "object concept" or the "concept of permanence") cannot explain this awareness. How *could having an idea of something* explain the awareness that it is lasting (or not lasting) ?"

- J.J. Gibson, Cornell Archive, 14.56, 1976.

In this way Gibson tried to explain the perception in terms of information about persisting surfaces. A driver for example has an awareness of the actual persisting road stretching and does not have an idea of or a memory of the road.

Gibson attacks this form of reasoning as paradoxical. It begins by assuming that the description of reality offered by physics is the correct and accurate description. From this we conclude that the world we live in is a construct of our imaginations. We do not see persisting objects so much as conceptualise or remember them. What we are supposed to see then is the flux of sensory impressions.

The long term aim of research is to give a single unified exposition of the idea that concepts figure in perception. We must however question whether this is possible. Do animals, for instance, possess concepts? Does a dog possess the concept of a cat or food or an owner? No matter how close extensionally a dog's concept of cat is to a human's it differs radically in that a dog cannot consider concepts. It cannot ask if it knows what cats are. It cannot wonder whether cats are animals. It cannot attempt to distinguish the essence of cats from the accidents of cats. Concepts are not things in the dog's world in the way cats are. Concepts are things in our world because of our language. Human language is intimately concept involving. Nothing can have the concept of snow the way a human can unless it has a way of considering snow in general or snow in itself. This is not for the trivial reason that it does not have a word for snow but because without a language it has no ability to wrest concepts from their interwoven and connected nests. An animal may have an idea what snow is yet have no way to use the concept snow, see D. Dennett, "Learning and Labelling", *Mind and Language*, 8, 1993, pp. 546 to 547.

If the ecological theory is logically and empirically possible then the question whether anything can be directly perceived as a such and such depends on how the sensory organs function. On non-ecological approaches when something is said to be perceived as a such and such what is meant is that it is perceived not only as objective but as something specific. The way the ecological approach seeks to explain how such specifically identified objects are directly perceived is through the notion of affordances. Things are not specified in terms of whether a concept is possessed or not but ecologically and perceptually in terms of what they afford the subject. On the ecological approach to perceive a chair we need not grasp the concept of chair but rather we need to pick up the affordance *sittable-on*.

The account of concepts is thus shown to be separate from the account of the ecological approach. Though we may perceive something as an object such as a tree say there is much we perceive that simply provides us with important information about our environment. We perceive the layout of objects, boundaries, enclosures and so on. We perceive what is grassy, sandy, rocky and so on. When perception is directed towards a particular object the features that we perceive are not qualities such as extension, shape and colour but are characteristics such as *sittable-on*, *graspable*, *edible* and so on. These are the features that an object has in virtue of the way a perceiver interacts with the environment. These are the affordances.

David Hamlyn has criticised the ecological account of how something is seen for,

"when an object in a given context affects a perceptual system in such a way that information is derived about it because of the structure of stimulation, the perceiver is enabled to see the object in a certain way, as a such and such. It is impossible to see something as X unless it has some idea of what it is to be an X. To say this is to say that it must have in some way, and to some extent, the concept of X. Thus to speak of it as obtaining information is not in fact to rule out as unnecessary any reference to concepts."

- D. Hamlyn, "The Concept of Information in Gibson's Theory of Perception", *Journal for the Theory of Social Behaviour*, 7, 1977, p. 14.

Hamlyn objects to the idea that information about the environment can be perceived directly and in particular without the aid of any intellectual processing. Hamlyn argues that it is not possible to have sensory information about an object unless it is perceived as such and such a kind of thing. For Hamlyn it is not possible to perceive something as a tree say unless the perceiver knows what a tree is and that to know what a tree is just is to possess the concept "tree". Hamlyn points out that if a concept is required then any such perception must have an intellectual component. Hamlyn also subscribes to the thesis that the answers to epistemological questions which are *de jure* or conceptual cannot come from a psychological theory.

One way to resolve the question whether something can be directly perceived as a such and such depends on how the sensory organs are identified, how the perceptual systems are defined and how both are supposed to function. Since their identification, definition and function are issues that are properly considered in psychology this argument if correct, would show that psychological theory can help supply answers to epistemological questions.

For Hamlyn, Gibson provides such an explanation insofar as he explains how a stimulus can carry information and how this information can be picked up by the sensory organs. This analysis is offered on the basis of Hamlyn's reading of the SCPS.

What the ecological approach in fact offers is a sensation free account of how something can be directly perceived as such and such. The functional identification of the sensory organs is a crucial aspect of ecological direct perception. A sensory organ is to be individuated in terms of its activity rather than by its anatomical boundary. One sensory activity may engage anatomically distinct units as for example in wine tasting. With respect to this activity these several senses comprise a unitary sensory system. Different senses may form subsystems of a superordinate system. Where a sensory organ is identified by its activity as either a single sense or

as a superordinate system of lower order sensory systems, it is called a perceptual system, see EAVP, pp. 244 to 246.

The perception of something as a such and such is contrasted with the perception of something as a this. To perceive something as a this is to perceive nothing about its individual distinctness. Accordingly things perceived this way are perceived as this and that. To perceive something as a such and such it is necessary to apprehend not only that it is numerically distinct from something else but also that it differs in some other way.

According to the ecological approach a perceiver senses one aspect of what is perceived as self-produced and a contrasting aspect as other-produced. If the individual distinctness of an object is to be perceived then the boundary of its surface that separates it from other objects must be detected. The information for this boundary is provided by a discontinuity in a self-produced optical flow. If I get up from this desk I will produce a downward perspective flow of the surfaces in my perceptual environment. There will be an abrupt difference or discontinuity between the velocity of the flow of the edge of the surface of the desk and that of the flow of the surface of the wall behind it, say. The former will move faster than the latter.

In such cases the boundary of each surface is the pattern that remains invariant relative to the self-produced perspectively changing pattern. In these circumstances the perceiver, in detecting the individual distinctness of each object, distinguishes between self-produced changes and other-produced invariants. The boundary between the surfaces in virtue of which these things are perceived as individually distinct is therefore perceived as objective. The surfaces accordingly are not only perceived as individually distinct but also as objective. They are therefore perceived as more than a this or a that. They are perceived to have an additional feature, namely the property of being objective. Because they share this property they have a suchness that distinguishes them from that which is subjective. This account is very different to that of Hamlyn who simply assumes that nothing can be perceived as an object without the possession of the concept of that object, see SCPS, pp. 195 to 203.

If something is so perceived as an objective individual and hence as a such and such it will be so perceived directly, that is without the intervention of an intellectual process, for this suchness is perceived as an aspect of a contrast that emerges from a sensory activity and, according to the ecological theory, the sensory organ is equipped to detect this contrast. Sensory information and sensory activity suffice to account for the perception of this kind of suchness. The answer to the question whether anything can be perceived directly as a such and such therefore depends on what the sensory organs do when they perceive.

The explanation of how an object is directly perceived as a such and such by the perception of affordances shares something with how it can be done in terms of concepts. In both cases the problem is to explain how something can be perceived not only as individually distinct and objective but furthermore as having some other distinguishing characteristics. If an object is perceived to have several different features then these features must be perceived as united in the object or as an objective unified combination. The problem is how to explain how such a combination can be perceived as objective and unified.

The solution to this question is given in terms of the functional identification of the sensory organs on the ecological approach. A sensory organ is to be individuated primarily by its activity rather than by its anatomical boundary. If a single sensory activity engages anatomically distinct units then these anatomical units will comprise a single perceptual system. When different senses contribute to a unified sensory activity they act as subsystems within a higher perceptual system. The higher order perceptual system perceives a unified combination of sensory features, such as the tactile and the vestibular, see D.A. Givner, "Concepts, Percepts, and Perceptual Systems", *Metaphilosophy*, 13, 1982.

Hamlyn assumes that sensory organs sense qualities. He assumes that whatever information is detected by sense must have a dimension of quality such as visual or auditory. The qualities he mentions go with the anatomically defined sensory organs. A unity of such qualities as considered by the ecological approach cannot be sensed by any anatomically defined sensory organ because such organs sense qualities and a unity of qualities is not itself a quality. This is the reason why for Hamlyn, and other conceptualists like him, a such and such insofar as it is a unity of qualities cannot be perceived directly.

There is therefore some difference between the kind of such and such shown to be directly perceived and that which is exemplified by perceiving a tree. The ecological approach requires that a such and take part in certain transformation to be perceived as a such and such whereas to perceive something as a tree is to perceive that it is similar to certain other things namely other trees. To perceive that something is similar to other things it is necessary to have perceived these other things on past occasions. The main difference between the kind of such and such that is directly perceived and what Hamlyn assumes to be a such and such is that the former can be sensed with a single act of perception while perception of the latter depends in some way on the past perception of other things. The perception of the former kind of object is not necessarily the recognition of anything. Hence we must now ask whether the perceptual

recognition of a similarity requires concepts or intellectual processing.

Gibson denies that recognition requires the matching of a percept with a concept. If recognition required this matching then,

"novelty would have to be a failure to match a new percept with an old one after an exhaustive search of the memory store, and this is absurd."

- SCPS, p. 278.

Such a concept involving account begs the question for knowledge of the world cannot be explained by supposing that knowledge of the world already exists.

Gibson doubts that abstracting is an intellectual act of lifting out something that is mental from a collection of objects that are physical, of forming an abstract concept from concrete percepts, see EAVP, p. 249.

The recognition of similarity however could be explained as an act that is essentially the perception and not the abstraction of an invariant combination of sensory features. The perception of something as a something requires the recognition that the perceived object is similar to other things. This will, at least in part, be the detection of a unified combination of features. If there is a unified combination of features which is perceived when and only when a tree is perceived then a tree will be perceived as a tree. When on later occasions that invariant combination is again encountered an object will be perceived and it will be recognised as a tree. When this tree is recognised it is also cognised as a tree because an invariant combination of features is directly perceived. It is re-cognised as a tree insofar as the perceiver is aware that this invariant combination is perceived again. Perceived again means directly perceived again. In this way the perceptual recognition that some object is similar to some other thing depends on past perception not for a concept and the cognition of suchness but for the knowledge that a directly perceived such and such is perceived again. Each time an object is perceived as an object it is directly perceived as that object, see EAVP, pp. 72 to 85.

Chapter Twelve: Illusion and Hallucination

The ecological approach provides a systematic way of dealing with cases of illusion and hallucination. They do not need case by case treatment from first principles. Illusion is to be treated separately from hallucination. This view is far from being unique to the ecological approach. The two kinds of experience are fundamentally different and are to be explained in different ways, see the lucid explanation given in A. Ben-Ze'ev, *The Perceptual System*, 1993, chapter 5.

Gibson and Ryle take "to perceive" to be a verb of detection. Both reason that a failure to detect something cannot be a kind of detection and accordingly illusory perception cannot be a kind of perception. Furthermore the ecological approach denies that there is any way to decide whether there is something in common between the veridical and the hallucinatory experience. Thus such phenomena play no role in perception.

On the ecological approach hallucinations are treated as unreal sensory phenomena that a subject may believe to be real. The subject may of course believe they are undergoing an hallucination. Hallucinations are to be considered apart from the sensory phenomena that are apprehended as illusory. On the ecological approach an hallucination cannot have the real quality of a veridical experience for the reality of veridical experience comes from the activity of picking up information whereas hallucinations occur independently of this activity. Hallucinations are produced by the brain whereas veridical experiences are not, see J.J. Gibson, "On the Relation Between Hallucination and Perception", *Leonardo*, III, 1970.

On the ecological approach veridical and illusory perception differ in that the former is an experience of perceiving something while the latter is irreducibly the experience of failing to perceive something. Thus veridical and illusory experience are not two kinds of perception. Only the former is perception. Illusion is not perception.

The commonplace view holds that perception can be conceived as an indirect result of a process by which the awareness of something perceived is in the end effect of the firing of neurones in the brain. The environmental object only initiates the chain of causes which results in perception and so that object is only indirectly perceived. When perception is so understood illusory perception is explained on the principle that such objects are always imagined as being present in the field of vision as would have to be there in order to produce the same impression on the nervous system. On this view veridical and illusory perception are both experiences of something perceived. The ecological approach rejects this account.

Illusions may be divided into optical illusions and sensory illusions. In brief optical illusions are due to particular diagrams or constructions whereas sensory illusions are due to particular circumstances.

The ecological approach explains optical line illusions such as the Muller-Lyer diagram in terms of the information available in the drawings when seen as constituting the edges of three dimensional objects. No connection between the information and the natural function of the senses is required. Both views presuppose some conception of how things look to people and this in turn requires something to be presupposed about their experiences.

On the ecological approach sensory illusion is the experience of failing to perceive something rather than the experience of perceiving an unreal something. It is not then necessary to explain how in the case of an illusion a non-existent object can be experienced. There is no reason to suppose that neural events cause a subject to have the experience of something which lacks physical reality but is phenomenally present. It is therefore possible for direct perception to dispense the explanation of illusion that says we immediately perceive only the indirect effect of the environment.

To support the view of the ecological approach we must justify the premise that an illusory experience is not the awareness of an illusory object. What the ecological approach is able to show is that an illusion is not an experience that is similar to the veridical experience of perceiving something. An illusion is irreducibly the experience of misperceiving a real object.

Fodor and Pylyshyn hold that one consequence of the ecological doctrine that the structure of ambient light specifies the layout of the environment is that a subject could have the experience of perceiving the layout of some environment in the absence of that part of the physical world. Such an illusion would occur if a subject in the absence of objects which normally produce some array of ambient light received that information from an artificial source. A picture may provide such information. Though to look at a picture, fixed or moving, may be regarded as a case of ecological indirect perception, it is not to have an illusory experience. Furthermore, on the ecological approach, the environment of a mobile perceiver is specified by the information that is available to the senses working together as a perceptual system. It is not clear how this kind of information could be made available artificially, see J. Fodor and Z. Pylyshyn, "How Direct is Visual Perception ?", *Cognition*, 9, 1981.

The theory of ecological direct perception has the following implications for illusions,

- 1) As proprioception and exteroception are both essential components of veridical perception so illusions cannot be

distinguished from veridical perception on the grounds that the former is subjective and the latter objective, and

- 2) If a perceiver fails in some way to make the distinction between the subjective and the objective then their perception will be deficient in that way and may in this sense be termed illusory. According to the ecological approach it is the perceiver's inability to pick up certain perceptual information that is responsible for the illusion of a room that is distorted but looks rectangular. It looks rectangular because the perceiver is allowed to view that room from only one stationary point.

That the illusory experience is not of an illusory object can be shown by examination of the auto-kinetic effect. This type of illusion is explained as a failure to pick up certain perceptual information and so to result in a failure to distinguish the subjective from the objective.

To achieve the auto-kinetic effect the subject sits motionless in a dark room illuminated only by a pinpoint of light. The eyes are fixed on this light and after less than a minute the light appears to move. To have this illusion it is necessary that perceptual information pick up is minimal and that the perceiver must not pick up what little information is available. If the perceiver moves the head then no illusion is experienced. The illusion only occurs where the perceiver is not allowed to engage in the activity that maintains the distinction between subjectively produced change and objectively produced invariance. If this illusion is a result of a failure to distinguish the subjective from the objective then this illusory experience is not the experience of seeing an illusory object, see R. Gregory and O. Zangwill, "The Origin of the Auto-Kinetic Effect", *Quarterly Journal of Experimental Psychology*, XV, 1963, pp. 252 to 261.

In the auto-kinetic effect the light is not seen as stationary. There are three alternative ways to explain this,

- a) The light is seen as moving,
- b) The light is not seen as moving,
- c) The subject is not perceptually oriented to the environment and is thus unable to see whether the light is stationary or has a changing location.

The ecological approach adopts option c) for the disorientation experienced by the subject of the auto-kinetic illusion is a failure to distinguish clearly between the subjective and the objective. The illusory experience is irreducibly the experience of failing to perceive or of misperceiving the location of the light. Here any analysis of the contents of the experience does not yield an awareness of an illusory

motion. This does not mean that the subject is not aware of a light only that it is denied that the subject is aware that the light is moving.

The disorientation experienced during the auto-kinetic illusion is a failure to distinguish between the subjective and the objective for in having the illusion the subject loses the sense of their position relative to the objective visual environment. To lose sense of position is not merely to lose track of something. The objective world's distinctness from the sensing subject is the subject's distinctness from the perceptual environment. To lose the sense of one's position relative to this objective frame of reference which marks the boundary between self and environment is to lose a sense of the distinctness between what belongs to the self and so is subjective, and what does not belong to the self and so is objective.

In this way the position of the light is not clearly distinguished both in the sense that the perceiver fails to make a distinction and in the sense that its position may, with respect to the perceivable characteristics "dependent on me" and "independent of me" be described as indistinct. Thus the illusory nature of the auto-kinetic case is a kind of indistinctness, one that is recognised as a consequence of the role of perception of subject and object differentiation. A subject and object boundary may be either clearly or unclearly distinguished. When either kind of boundary is not clearly distinguished the subject experiences something indistinct.

The perceptual environment is bounded by the extent of the perceptual field. Movement of the perceiver and thus the perceptual systems generates a contrast between the subjective boundary of the field of view and the objective world that is being viewed. When the motion of this boundary is not perceived as self-produced nor as other-produced the perceiver experiences vertigo. Vertigo is an experience of a breakdown of the distinction between subject and object and as such this experience serves to illustrate the point that a loss of distinctness between subject and object is also experienced. This is the kind of failure that is experienced with the auto-kinetic illusion. The subjective and objective indistinctness of the illusory motion of the light is at the same time the experience of failing to make the distinction between the subjective and the objective.

When a subject fails to distinguish clearly between the subjective and the objective the indirectness that is experienced as a result of this failure is not an illusory object. That indistinctness is not an inspectable object of perceptual awareness such as a blurred photograph.

Those who hold that a sensory illusion is of an illusory object hold that an illusory experience divides itself between the state of awareness of the subject and the object of that state of awareness. The object of that state of awareness is the content of the illusory

experience. G.E.M. Anscombe claims that there is a sense in which it is true that one who sees, even when perception is illusory, must see something for there always is some content of his visual experience. On the ecological approach this is not so, see G.E.M. Anscombe, "The Intentionality of Sensation" in R.J. Butler (editor), *Analytical Philosophy*, 1968.

To describe the contents of an experience, and to thereby single out an object of awareness, is to limit the description to that and only that of which one is aware. Accordingly the perceiver who initially says they cannot see anything and means they cannot make out any of the objective details of the environment at which their eyes are directed is instructed to ignore the fact that they cannot discern these features of the environment and instead attend to just those things of which they are aware.

The auto-kinetic illusion is not of an illusory object. The perceiver does see something and does have an illusory experience. The illusory nature of the experience is the subjective-objective indistinctness of the position of the light. Accordingly the experience need not be wholly illusory or wholly visual. Only some parts of the experience may be indistinct. Anscombe and others like her, are mistaken in supposing that the doctrine that illusory perception is not the perception of some kind of object entails that such perception must be of nothing whatsoever.

The ecological approach does not deny that the subject has an illusory experience. The illusion is a kind of indistinctness and the subject has an experience of that. This indistinctness is not an illusory object. It cannot belong to the object that would be distinctly seen if it were possible to differentiate clearly between the subjective and the objective. This indistinctness is not a characteristic of either an illusory or a real object. If the subject is not aware of an illusory object and the only object of this indistinct perception is the thing that would be clearly seen if vision is clear then this experienced indistinctness can only be the experience of not distinctly perceiving or of misperceiving an object that is inherently distinct.

On the ecological approach certain cases of illusion have neither a need nor a justification for the belief that an illusory experience is of an illusory object. This stands for any illusion which is the result of a failure to distinguish between subject and object. In any such case it can be inferred that there will be a resulting indistinctness. The experience of this indistinctness will also be the experience of a failure to make the distinction between the subjective and objective. In these circumstances the indistinctness is something the subject is partly unaware of and cannot therefore be an illusory object, see D.A. Givner, "Direct Perception, Misperception, and Perceptual Systems", *Nature and System*, 4, 1982, pp. 131 to 142.

In the case of other illusions it should not be assumed that the experiences either are or are not of illusory objects. In this way it is possible for ecological direct perception to explain illusion.

Chapter Thirteen: Representation and Image

Many theories of perception rely on representational accounts. The representations are usually taken to represent information about the world. By definition no representation can violate or arbitrarily recode the structure of the information it represents nor can a representation contain more information than exists in the perceptual array. In general, whatever information is directly available in the representation of an array must also be directly available in the array.

The ecological approach is not a representational approach; it does not involve representations. Perceptual information pick up is just what it is for the perceiver to perceive the way things are around them. The ecological approach offers two considerations here:

- a) The content of the representation is not independent of how things are in the environment, and
- b) There are no stages in the construction of a representation. It is produced directly.

The ecological approach raises a difficulty for philosophical accounts given by those such as Moore, Broad and Chisholm. On this account cases of seeing are characterised as if the observer is fixed rigidly and as if the object the observer is looking at is motionless. The question then asked is "how much of the object can the observer see from that particular standpoint at that moment ?". This is a question that can only be asked of an observer in exactly that situation. The question is appropriate only in certain circumstances. The ecological approach shows that it is a mistake to hold that normal cases of seeing are like that.

Normal cases of seeing are those in which a perceiver is moving through an environment, looking around while moving. In these circumstances a perceiver picks up certain invariants in the environment which allows them to see more than merely part of the surface of the object that would be facing them were they standing motionless. Surfaces appear and disappear as the observer moves through their environment. This movement is continuous so that without interruption the perceiver perceives parts of the object that would not be seen if they were standing motionless. The crux of this account is the ecological notion of whole object.

The ecological approach defines a representation as an object that stands for another object as a surrogate. This is established functionally, that is it is the use of one object by some user as a representation that makes the representing object a representation. This is an act of representing.

The relation underlying both representation and perception is specification. To be a representation the surrogate must specify that which it represents to someone. It may do so symbolically in virtue of arbitrary rules known to the user including associations or it may do so figurally by virtue of some lawful relation. It may function biologically but it must nonetheless specify. In this way representation depends on successful specification.

Specification may be demonstrated ostensively by successful acts involving pointing. What is important in pointing is direct specification. Representation however is a form of indirect specification as shown for instance when some aspect of a scene is pointed out to someone by inspecting a picture or a symbol rather than the scene itself.

We may develop a theory of direct specification. On such an account representations would be required in an explanatory role in theories of memory, concept formation, problem solving and so on, but would not be required in theories of perception.

Another important philosophical issue is how the person is related to the representation. That one does not need a perceiver or a user for representation may provide a source of confusion between ecological and non-ecological accounts. Indeed, as with the term "information", it is may be difficult to find agreement on the correct use of the term "representation" itself. These issues may be clarified by careful reference to the meaning being employed by the particular account. Gibson himself actively avoided the term "representation" especially as it is not necessary for the ecological explanation of perception.

Representational philosophies hold that what is directly perceived are mental representations and it is only indirectly through the mediation of these representations that we perceive the external world. In answer to this the ecological approach holds that the perception of environmental objects and features is based on the ambient information available.

As a form of direct realism the ecological approach challenges representationalism arguing that it is possible to perceive the external world directly on the basis of information and not indirectly through images and mental representations. According to the ecological approach what is usually referred to as "the basic process of perception" is direct and occurs independently of representation.

"A theory of direct perception is only possible because there is information in the ambient array that specifies events, objects and so forth in the world (the word *direct* here does not refer particularly to a processing theory)."

- M. Hagen, *Varieties of Realism*, 1985, p. 241.

Many common theories of perception take inferential processes to be essential for cognition. Both opponents and proponents of the ecological approach such as Fowler have treated the ecological theory of perception as eschewing reference to representations and cognitive processes, see C. Fowler, "An Event Approach to the Study of Speech Perception from a Direct Realist Perspective", *Journal of Phonetics*, 14, 1986. This is mistaken. In arguing that it is possible to perceive the world directly the ecological approach does not claim that indirect, or mediated, perception was impossible.

The ecological approach does involve representations in certain important roles. These may be referred to as ecological representations. Ecological representations include depictions, indications, signals and symbols. They all evolved in a context of shared awareness. Almost all the fishes, birds and mammals that live in families or larger groups have evolved the ability to display at least some information so as to make it available to others thereby making their conspecifics aware of important environmental and social facts. These displays involve, among other things, gestures, vocalisations and the production of scents. In addition to having extremely sophisticated gestural resources humans have evolved various means of marking surfaces and vocalising that have systematised our skills of indirect perception. This kind of derived information may have its origin in ecological information but it can be significantly modified by species specific traits and circumstances. All such derived information may be described in terms of ecological representations.

To account for this the ecological approach makes a distinction between vision as direct ecological information apprehended either directly or indirectly and vision as derived from ecological information □that is vision as representational information. There is a need to evaluate the different ecological representational information rather than a need to evaluate the idea or the role of representation itself.

The ecological approach draws a sharp distinction between information based and representation based vision,

"The various affordances of surfaces, substances, layout and events get perceived in the course of the development of the young animals by maturation and learning taken together, by *encountering* the surfaces in the habitat, without schooling. On the other hand, the referential meanings of marks on a surface get apprehended by children in ways that differ from the preceding, and also differ from one another. They are different for pictures, drawings, plots, signs, and letters of the alphabet. At one extreme, photographs are independent of cultural conventions. Drawings and diagrams are at least somewhat conventional. However different the learning of

pictorial reference may be from the learning of linguistic reference. They *are* very different. They are even more radically different from the learning of what surfaces afford. Encountering those marks is not enough, and the more they vary with the culture to which the growing child belongs, the more this is true."

- J.J. Gibson, "Foreword", in M. Hagen (editor), *The Perception of Pictures*, Volume I, 1980, p. xiii.

Affordance meanings can be perceived directly when information specifying them is available. They can also be perceived indirectly when someone selects and displays that information in one or another form of representation such as using pictures or language. Pictures and words are meaningful in a way that is partially historical and partially cultural as well as ecological.

The task of perceptual study is not to detail representations. It is wider and broader than that. The task of ecological perceptual theory is the development of mutually compatible theories of environments and organisms, and the epistemic and informational constraints which bind organism and environment in a reciprocal relationship.

Representation and Realism

Many widely held positions oppose Gibson over direct realism. In many cases this opposition to direct realism is the only explicit reason for their opposition to the ecological approach. Granting the differences among themselves they can be broadly characterised as representative realists. This means that they all hold that the human visual awareness of external phenomena is constructed out of neural processes and brain functions of complex sorts that are in some important sense internal. They all accept some argument whose conclusion is that we do not perceive the external world directly and so all run counter to the ecological approach.

Lynne Rudder Baker gives a taxonomy of representative realists that includes functionalists who take mental states to be capable of multiple physical realisations, type-type physicalists who take types of mental states to be nothing other than types of physical states, some Cartesian interactionists who take changes in mental state to cause changes in brain states, epiphenomenalists who take changes in mental states to be caused by changes in brain states and some token-token physicalists who take tokens or datable occurrences of mental states to be identical with tokens of brain states, see L.R. Baker, "Just What Do We Have in Mind ?", *Midwest Studies in Philosophy*, 10, 1986, pp. 25 to 48.

Ecological direct realism opposes all varieties of representative realism. The issue that divides them is whether we are to include representations in our realist accounts of the environment, of the

mind and of perception. The question here is whether the ecological approach can do without such representations.

The nature of the dispute between these views and ecological direct realism may be illustrated by contrasting the ecological approach with the functionalist, eliminative-materialist position on the nature of the mind.

In support of the direct realist point of view Gibson says,

"Direct perception is what one gets from seeing Niagara Falls, say, as distinguished from seeing a picture of it. The latter kind of perception is mediated. So when I assert that perception of the environment is direct, I mean that it is not mediated by retinal pictures, neural pictures, or mental pictures. Direct Perception is the activity of getting information from the ambient array of light. I call this a process of information pick up that involves the exploratory activity of looking around, and looking at things. This is quite different from the supposed activity of getting information from the inputs of the optic nerves, whatever they may prove to be."

- EAVP, p. 147.

For "picture" we could substitute "image", "representation", "brain state" and so on. All are supposed to mediate perception and thus impede or would impede the direct apprehension of an external object. How this may be is unclear. In the ecological approach the term "direct" is used to oppose mediation by a perceived item. The ecological approach is against mediation by any such item.

There is no reason to suppose that the world or our actions upon it must involve a representation or image of achievement. There is therefore no reason to suppose that a philosophical argument or experimental evidence requires the postulation of internal representations. Rather than argue that internal images are somehow perceived we may suppose that whatever mechanisms perceive the image perceive the environment. The postulation of an internal image adds no further explanation. It simply places the account of perception inside the perceiver. Asking how cortical images are perceived puts the theorist on no sturdier footing than asking how environmental events are perceived. It only serves to shift the problem elsewhere.

It may be judged that even if all that the ecological approach offers were correct it still does not explain what occurs in the brain. This view implies that the brain is where seeing really takes place. In this way the problem of perception can only be solved by understanding how the brain works. Patricia Churchland, for example, offers an extensive presentation of just such an approach in her

Neurophilosophy, 1986.

According to the ecological approach perception concerns perceivers, and brains are not perceivers. No brain ever perceived anything. For these reasons the ecological approach features no explanation of the functioning of the brain or what goes on in the brain. Such matters are irrelevant to the account and explanation of perception and in particular visual awareness. Perception is a matter of ecological direct realism.

The argument for representative realism begins with the assumption that light is reflected off the surface of an external object, is transmitted through space according to the laws of optics and is then picked up by the human visual system. This includes the eye and its various features, cones, rods, the retina, the optic nerve and the brain which processes the material it receives through this causal chain.

Accounts differ as to the last event in this process. On some versions it is a representation that somehow reproduces the object. If the representation is really the last event in the causal nexus it is identical with what is usually called "seeing". On some versions the representation is the last event in the casual sequence before seeing occurs.

It strikes us that we see things directly without mediation. To those aware of the complex causal sequence as depicted in any representative account it seems obvious that the external object is presented to us by means of mediating factors. We do not really see the object directly but reconstruct it from the information directly provided by such intermediaries.

From this the problem of perception is how to explain the fact that the ultimate datum in the causal process represents the external object. Philosophers taking this view are realists. They believe there is an external world that exists independently of its being perceived and that the causal theory relies on there being one. They are not direct realists for they hold that, in their own terms, the terminal datum that an observer directly apprehends is not identical with the external object but in some way represents it. Many such philosophers would deny that they are speaking about pictures, images or sense data yet what they call representations are similar to sense data in that both mediate perception. With their causal, mediated account they fall foul of the ecological account of perception, irrespective of any subsequent theoretical explanation.

Images and the Ecological Approach

Compared with the representational account the ecological approach downgrades the role of images and imaging in perception. According

to the ecological approach images are to be accounted for in the following way,

- 1) The object is present to perception such as a reflection in mirror, glass, or water.
- 2) The object is not present.
 - i) The image is broken up and assembled as with a television picture or a photograph for example, or
 - ii) The image is a given such as a memory or is before the mind.

In this way ecological philosophy is able to show how perception and perceptual awareness may be accounted for in ways that do not require the involvement of images.

Imagistic theories in general begin with the assumption that it is an image or its analogue that is directly apprehended and they assume that images take a special form.

From an ecological point of view, images are nothing but flattened out objects, pancakes of solid bodies. We are therefore to reject all such imagistic assumptions for strictly ecological reasons, understood once we appreciate the place and role of the ecological environment.

Once theorists adopt such assumptions they are faced with the problem of how it is that we seem to see depth, roundness and the arrangement of objects in an ecological environment directly. Their answers are that we do not see these features directly. What we see are images. The features we seem to see directly are inferred or learned and constructed from the representations we apprehend directly. The central problem for them, as they see it, is to show how such constructions take place. In this their problem is not dissimilar to the sort of difficulty early Renaissance painters confronted whose solution was to devise a series of perspective techniques and is hardly applicable to human beings for serious psychologists.

According to the ecological approach any theory based on such models misrepresents the way perception takes place and founders on the problems it raises. The function of perception is to help the organism cope with its environment. Perception is at its simplest when it fulfils its function, not when it meets the criterion of one-to-one projective correspondence in geometry. Such an imagistic approach cannot for example explain why objects in the visual field are seen to be upright when the retinal image that is supposedly directly seen is inverted. The ecological approach rejects the assumption that we see the retinal image at all or indeed any images in normal seeing.

On the ecological approach images are tied to the notion of perceptual information. We see affordances provided by the ecological environment directly. A perceiver perceives a perception and this perception may be an image of something. There is no further use for and thus no further place for images in the ecological philosophy of perception.

Chapter Fourteen: Computation and Processing

Computation and Ecological Perception

The computational model of the mind holds that the mind is the software and the brain is the hardware of a complete computational system. The mind is to the brain as the software is to the hardware.

Computational theorists hold that how the perception is marked out is of the essence of perception and whatever information is picked up needs to be processed. This comes to involve the explanation of mediated perceptions, mental representations and complicated computational processing. For all their efforts computational theorists admit that they are not near to delivering an account of perception as experienced. Unlike the ecological approach they have no account of perceptual awareness.

Many commentators debate whether computation and representation exhaust what is meaningful about the philosophy and psychology of perception. This does not address the issue of whether computation and representation can say meaningful things about perception in the first place.

Arithmetic computations and inference making are inadequate models for perception for such approaches do not give an explanation of perception as perceived by perceivers. They do not give an ecological explanation. Producing an image on a screen does not do this work. To model parts of the brain and their alleged operations in computational terms shows nothing about perception. It has still to be shown that there is any analogy between perception and computation at all. Any such analogy requires a full description of perception in its own terms.

The information processing approach takes the high speed digital computer as its model of the activity of the nervous system and introduces the organism's knowledge into this account. In this way it attempts to explain how animals infer the world from the states of their nerves. This stands apart from other common types of perceptual explanation.

Confining investigation to the *intrinsic* workings of a device be it a computer, brain or clock omits the rationale for its structure and function. The answers to questions of structure and function are not to be answered by looking within. The reasons for psychological and biological structure and functioning are to be found in an analysis of environment in which they exist and upon which they operate. In this way the ecological approach denies that the brain draws inferences from the deliverances of the senses and asserts that perceptual systems detect the affordances of the environment.

The ecological approach is often contrasted by commentators to the computational and information processing approaches. Although it is a form of direct perception it is not diametrically opposed to the work of Marr, or to connectionists, AI scientists, engineers working in the field of perception and cyberneticians utilising machine vision. It shares with them an appreciation of the task of perception namely to enable the perceiver to get around and survive with success in the perceiver's environment. For example both a line assembly worker and a car door fitting robot must be able to fit doors to cars in a factory environment. Though the respective analyses of perception and of how the perceiver is able to perceive are very different these differences are not necessarily hostile to each other.

For psychologists such as Ullman and philosophers such as Fodor the problem with the ecological approach is that it has no computation in the account of perception. For such critics every account of perception requires some computational description.

If perception involves computation to extract static and dynamic properties of the intensity array then it will be difficult to make out a case for direct perception. The computational approach that comes closest to the ecological approach is not a common case such as that outlined by Ullman but is one that sees perception as parallel distributed computation in which a large network settles into a particular perceptual state under the influence of input through the retina and other organs of perception. The work of Marr fits this approach well. This is not a standard symbolic information processing account for it does not involve decisions about which rule to apply next.

That the ecological approach holds perceptual information to be available in the optic array sits better with the parallel distributed computational metaphor because a distributed parallel system is able to do a lot of computation to extract complex static and dynamic properties of the intensity array more or less simultaneously and continuously. It is this simultaneity and continuity which gives grounds for the comparison with direct perception. The danger for such an account is that it conflates what the ecological approach takes to be the operations of the perceptual systems with the pick up of perceptual information.

In general the problem with anti-computationalist arguments is that they make appeal to intuitions about the role of consciousness. Computationalists claim it is not clear that other approaches are better placed to explain the role of consciousness in vision than a computationalist approach. The ecological approach contests this claim at length with for example the discussion of affordances.

Many of the problems computationalists find with the ecological approach are resolved by an understanding of the notion of

ecological resonance. On the ecological approach the perceiver resonates with ambient ecological information. The perceptual system registers this information directly. It does not calculate them. It is important to distinguish between the detection of ecological information through resonance and the computation of higher order ecologically available information from lower order or other types of variables. The former is indicative of the ecological approach whereas the latter characterises non-perceptual analyses often used by the computational approach. Indeed the source of strongest objection to resonance to information is the doctrine that perceptual information must be calculated from more elementary variables.

The ecological alternative to this doctrine states that the invariants specifying salient dimensions of the environment are detected not computed. The perceptual system may be likened to a real world device that registers a higher order property without computation.

Further problems stem from the consideration of perception in terms of input which often results in an account of perceptual systems as a series of singular stimulus-response linear causations. For perception this produces image formation such as retinal image formation or field pattern analysis. For computation the problem is how so many individual pieces of data can be processed in the short space of time available. For perception the solution is to abandon the linear causation model and to adopt reciprocal systems involving the perceiver and the environment. As we have seen, perceptual resonance is the key to the explanation of the reciprocal relationship between the perceptual systems and the environment.

Computational approaches to perception have retained an input-output, stimulus-response ontology whilst adopting a parallel distributed, as opposed to a reciprocal, approach. This adopted parallelism has resulted in what is known as connectionism. Here the inputs are connected not in a linear causal chain but in the manner of parallel processing. In this way it claims to produce and to explain the required output that is the perception. Connectionism, as with the linear causal chain computational analysis, fails to re-address the ontological issue and forces perception into the previous input-output ontological outlook. Connectionism may be contrasted with ecological resonance and parallel distribution may be contrasted with reciprocity. The ecological approach takes perception from its first principles. It builds the ontology of perception from the study of perception and not from the study of physics or from the study of computation.

It is clear then that computational theories are not, and cannot be, ecological theories. Computer storage serves as a metaphor for inputs and so memory consultation still has a role to play in the computational account of perception. The ecological theory of perception is a theory of information pick up. It differs from many

other theories in rejecting the assumption that perception is the processing of inputs where these inputs are sensory or afferent nerve impulses to the brain. Information does not have to be processed. Perceptual information is not a product of processing. It is not processed. It is picked up directly. Perception is not mediated. Reason plays no role in perception. No mental processes are involved. Speculation about internal mental processes is superfluous for the information reaching the senses is much richer and more organised than on the processing account. We are surrounded by a world of organised stimuli that manifest themselves without the intervention of computation.

Pylyshyn on Perception

Zenon Pylyshyn has argued that there must be an interface between semantically interpreted symbols and physical properties. For Pylyshyn this is the essence of perception. Attempts to explain perception by linking percepts directly to the perceived properties of the environment will fail where the causally characterisable link suffers from over constraint. This causal link is only a very small part of the relation between percepts and the environment. The rest of the relation is mediated by inference or semantic level principles which is also true of putative mixed vocabulary principles and for the same reasons. To place too many constraints on the causal link is to invite counterfactual consequences, see Zenon Pylyshyn, *Computation and Cognition*, 1986, pp. 141 to 191.

The view that perception is cognitively penetrable is the reverse of the ecological view that everything we see is directly picked up. The reason given why the ecological approach cannot be sustained is that very few properties and, in particular, only certain functions over physical properties are directly picked up. The ecological approach does not require direct pick up of every cognitive phenomenon but only that of perceptual information. Pick up of perceptual information is what defines perception and distinguishes it from indirect cognitive phenomena.

Pylyshyn sets out various charges against the ecological approach. He begins with the claim that it is the vocabulary of contemporary physics that makes it possible to capture the laws of nature in the scientific way we are aware of. If we were to ignore the vocabulary of physics and describe the physical events that cause cognitive state changes using some other set of terms, say only terms that refer to perceived properties such as affordances, we would lose the only coherent way we have of talking about all aspects of the physical world.

What Pylyshyn claims to be the case is not true, and cannot be true. To propose a description of perceptual properties in terms of

perceptual properties is correct if only because it increases the ways we have of talking about the various aspects of the physical world.

The general move specifically proscribed by Pylyshyn is to assign any supposed deep mysteries of perception and cognition to different places and so make the apt currently under research either surprisingly simple or impossibly complex. This allocation of complexity is widespread in psychology.

The ecological approach argues that difficulties surrounding cognitive processes can be simplified when the supposed complexity of cognition is seen as the behaviour of the cognisant organism in its own structured environment. In this way cognitive processes are reduced not in complexity but in functional role. The ecological position is not that complex cognitive processes are explained in terms of the environment but that many of the difficulties that cognitive theorists have are difficulties just because they attribute to cognition and cognitive processes functions and abilities that are neither functions of cognition nor indeed cognitive processes at all.

Pylyshyn goes on to ask whether perception is direct, framing the question in terms of his own indirect cognitive processing theory. For him direct realism is the antithesis of the computational approach. In particular the computational approach takes the position, apparently unsupported, that perception and cognition involve a great deal of computation which necessitates talk of primitive operations, inference, memory and representation.

Pylyshyn talks of perception under ecologically normal circumstances without taking into account the fact that ecological circumstances are the norm of perception. Hence ecological direct perception is the norm. Direct perception involves no construction of enriched representations. If enriched representations are present then they are in no way perceptions. Perception is not a question of epistemic mediation by knowledge, expectations, memories or inferences.

According to the ecological approach perception involves the detection of perceptual information present in abundance in the environment. This information is picked up by an organism resonating with the environment. In this way perception is not in any way inferred or reconstructed.

This ecological elimination of mental constructs and constructed representations from perception shares something with behaviourism. Pylyshyn makes much of this point. He claims that directness fails for the same reason behaviourism fails. Pylyshyn claims that direct realism presupposes that organisms detect directly these categories of things in the environment needed to account for the subsequent behaviour of the organism.

The ecological approach does not, as Pylyshyn supposes, adopt straightforward behaviourism. In a behavioural analysis recognition of a stimulus, response and reinforcer is presupposed in ways that are outside the theory and so a behavioural analysis cannot give an account based on conditioning of what constitutes a stimulus response or reinforcer. These are the objects the organism must individuate by picking out or encoding and so on, prior to subsequent conditioning. In behavioural terms the environment of the organism consists of just such entities. The ecological analysis of the environment is sophisticated and complex. In his criticism Pylyshyn omits any positive reference to the environment thereby overlooking what is central to the ecological approach.

The reason Pylyshyn and similar computationalists postulate a role for representations and inference in perception is that they require what is directly picked up to be only those properties for which the organism has transducers. Transducers are said to be primitive mechanisms of the functional architecture constrained in certain ways. They modify what is directly picked up as part of the perceptual processes so that what is transduced is not the same as what is perceived. Transducers are no part of the ecological approach. Pylyshyn has, on the ecological approach, deprived his perceptual system of the information it uses.

Pylyshyn goes on to state that we perceive meaningful objects and relations. We categorise them according to our knowledge and in terms of their function and so on. That I know what a cricket bat is generally used for and recognise it as such is a separate matter to seeing a cricket bat. In this way seeing an object differs from knowledge about that object. In order to account for this and to make up for the perceptual information deficit Pylyshyn is obliged to make perception highly penetrable by cognition. This runs counter to the ecological approach and to many other accounts including Fodor's modular picture of mind.

Alongside this Pylyshyn insists that the ecological explanation of spatial perception is vacuous because it lacks principled constraint on the notion of information pick up. With respect to the environment ecological perception involves active exploration by an organism of the space around it. This exploration may be described as the dynamic sampling of a space of potential, proximal stimulations. The totality of such potential stimulation is systematically, and for the most part unequivocally, related to the distal environment. Ecological optics constrains the way in which the space of proximal stimulations provides unambiguous information about the layout of objects in the environment. With respect to the perceiver direct pick up of information is constrained by evolution, the species and individual organism in question.

In accounting for cognition and perception Pylyshyn downgrades the place of the environment, the whole organism and the resonant, reciprocal relationship between the two as well as other faculties and functions of the organism. Pylyshyn uses computation both defensively and offensively issuing demands for particular explanations and constraints which come to focus on computational explanations of computational variables and computational constraints on computational variables.

Fodor and the Ecological Approach

Jerry Fodor is famous for his extensive discussions of issues in the philosophy of mind, not least of the nature of mind itself. It is useful therefore to compare his conceptions of mind, sensation and perception with those of the ecological approach. In particular he has addressed the question of how the mind relates to perception. With respect to Gibson's part in the discussion of this question his comments are somewhat unfortunate:

"I am deeply unmoved by the Gibsonian claim to have devised a non-computational theory of perception. I propose simply to ignore it."

- J. Fodor, *The Modularity of Mind*, 1983, p. 133.

For present purposes, I propose to examine Fodor's work on its own merits, irrespective of his personal opinion.

For Fodor the mind is modular composed of functionally and semantically distinct modules. By contrast people are a unity of meaning within which everything is related and inter-related. There are classes of psychological processes such as perception, that function according to specific laws and are barely influenced by other psychological processes. Fodor would prefer them to be completely independent but settles for bare influence. This departs from ecological direct perception which while holding a link between cognition and perception does not find perception to be a cognitive process. There is no place for processing in ecological perception. This is in contrast to many cognitive scientists who continue to develop and elaborate processing models and themes, see J. Fodor, "Why Should the Mind be Modular ?" in A. George (editor), *Reflections on Chomsky*, 1989.

In terms of the modular mind perception is an encapsulated process that may initially be related to other mental processes but goes on to lead a life of its own. There is an information channel whose flow is set up for perception and may be regulated by cognition or a causal relation of perceptions and cognitive effects. The memory, and in particular, rememberings could be modelled in such a way. These processes give the modules of a modular picture of the mind. For

Fodor perception and the other psychological processes are interwoven with cognition.

Cognition characterises a process as a process of the mind, that is a mental process. On the modular picture the mind can be split into functions that partially penetrate each other. Though this is not an ecological analysis it shares the desire to produce a functional explanation of perception with the ecological approach. Disagreements occur over which functions count as cognitive functions and over the hierarchy, if any, of the functions, see, for example, the discussions contained in B. Loewer and G. Ray (editors), *Meaning and Mind*, 1990.

Fodor himself proposes a hierarchy of mental processes governed by the rule that a higher process is not involved in a lower one. Fodor attacks previous accounts for adopting either bottom up (from an account of each individual process to an explanation of the whole organism) or top down (from an account of the whole organism to an explanation of each process of that organism) analyses. For Fodor this whole concern is not an either/or matter.

Neither, what Fodor refers to as, bottom up nor top down procedures are satisfactory for the philosophy of mind for neither captures the modular nature of the mind. Bottom up analysis is to be avoided for the processes under study are more likely to represent the physical prejudices of the theorist concerned than reality. Top down analysis is of no use for it is inconsistent with the premise that higher mental processes are not involved in lower ones.

The ecological approach too rejects such bottom up and top down methods. It may agree with Fodor's criticism of the bottom up approach but must disagree with his criticism of the top down approach for this objection rests on the notion of cognitive, including perceptual, processes.

For Fodor higher cognitive processes are free floating and cannot be contained in stage models. They function in a Quinean manner, that is to say modifications to one part of the system affect all other parts in a different though determined way, see R. Cummins, "Review of J. Fodor, 'The Modularity of Mind'", *Philosophical Review*, XCIV, 1985.

The ecological approach encourages a view of perception as involving a variety of widely differing factors. It does not hold the mind to be a set of psychological modules of processes tied together cognitively to make up a mind. Any such bundle theory is very far from the ecological approach. The ecological approach does not hold perception to be a cognitive process nor an indirect process. Perception is an ecological feature of environment and organism. There may be cognitive processes but as what they produce is

produced indirectly they are not perceptual. Ecologically there are no perceptual processes.

Fodor is a mentalist. He believes there are mental processes and that these processes are necessary for the normal functioning of the mind. The ecological approach is anti-mentalist about perception and resists the mentalist picture of the mind. On the ecological approach perception is not cognitive in the way often discussed by cognitive science.

Perception is much more a matter of what goes on outside the head than what goes on inside the head. Visual perception is a selection of the information present in the ambient light. It does not depend on inferences. In this way perception is direct and not mentalist.

Processing and Ecological Perception

Ecological perception is direct. One consequence of this is that there is no processing in perception for processing and perception are different and require different theories and different explanations. Cognitive processes are part of a theory of indirect cognition whereas ecological perception requires a theory of direct perception.

Neisser suggests that Gibson's rejection of processing is not based on a genuine assessment of what processing theories may contribute in the future but rather on their past failures and inadequacies. Because all theories so far have been based on an unsatisfactory description of the stimulus it may be supposed that any which may be devised will be equally unacceptable. So better no theory at all than another series of hypothetical processing stages that are supposed in some way to endow raw sensations with meaning. This is not the case. The ecological approach has in principle no place for processing in perception, see U. Neisser, *Cognition and Reality*, 1976.

Though the ecological approach provides insight into the part the environment plays in perception it may be thought to fail to account for the internal processes which constitute perception. These processes may be straightforwardly physiological or informational or computational. What is necessary is that they are perceptual and therefore explanatory of perception. Gibson gave no account of any such processes because according to the ecological approach are none. No internal perceptual processes are required for perception and none exist. Perceptual processes are mythical.

Part of the achievement of the ecological approach is to give a complete account of perception, including visual awareness, that has no role for and needs no role for any purported internal processes. This achievement is a central part of the ecological approach.

Nevertheless it must be asked how and why it is that commonplace views about perception including the physiological and computational accounts place such an emphasis on the existence and role of processes and processing.

The physiological approach to perception is based on the premise that light goes to physiological processes. This premise is filled out with an account on which light reflected from an object impacts on the body producing initial physical effects. These lead to transformations at the physical level and subsequent derived physical effects resulting in the perception of that object. In this way there is a route from object to light to body to transformations and so to perceptual phenomena.

This is deceptively simple. Light itself is not a perceptual phenomenon. Physiological processing is required and this takes time. Accounts based on physiological processing render perception far slower than it really is. For example the time to react to catch or to avoid a thrown ball is of the order of 0.05 seconds. Clearly the perceiver complete with physiological mechanisms is able to do this yet the physiological approach as it stands cannot deliver an account of this in such a short span of time that is satisfactory in its own terms. Adopting a computational analysis adds to the problem for this breaks the physiological processes down to further computational processes and attempts to reconstruct perception from the resulting multiplicity of computational pieces. A computational analysis of the physiological analysis of perception needs a way of processing all the computational pieces in the right sort of way and on the right sort of time scale.

The ecological approach does not debate the assignation of distinct psychological functions in the visual pathway. The ecological approach disputes the physiological and computational notion of the visual pathway. It is not clear that there is any ecological visual *pathway* at all, for to think of perception in terms of pathways is to fundamentally misunderstand the nature of perception itself.

There is rather a way of having visual perception. This way rests on the ecological notions of reciprocity and resonance and the metaphor of a radio surrounded with information most of which is redundant. The radio metaphor of resonance is a functional metaphor. The perceptual system resonates with the environment in such a way that the perceiver has perceptions. Perception is a natural, ecological phenomenon. There is no unidirectional causal account of perception. There is no path for perception to travel.

It is not satisfactory to simply claim that two different things are being discussed here. The ecological approach addresses perception itself. Those concerned with visual pathways may indeed be concerned with features of or processes of the brain but it cannot be

conceded that such things are perceptions nor, thereby, that those things are in any way perceptual.

There is a purely computational approach to perception that is not concerned with the way perceivers are but only with achieving results that may be described as perceptual. On this approach computational processes are devised in whatever way necessary to produce perception, irrespective of whether any other organism perceives in this way or ever could perceive in that way. Theoretical and experimental evidence from the study of robotics suggests that with perception far too much goes on in far too short a space of time for any purely computational analysis to deliver anything which may properly be called perception. Even with parallel distributed processing models achieving anything like mammalian perception is proving immensely difficult. To dodge or catch a ball and to blink for instance requires reflex actions and the ability to predict where the ball may be in the immediate future. These reactions do not seem to fit a computational model.

Perhaps it is simply a matter of a technology gap, and given time the technology will catch up with the theory, but given the difficulties encountered it is reasonable to conclude that whatever perception is actually like it is not straightforwardly computational. For instance one question here is whether perceptual reaction is a matter of object movement or eye movement. This can be addressed by measurement of the percentage of retina covered by shadow a set time. The results of recent experiments are ambiguous between the two options but conform to a notion of some sort of direct selection.

The computational approach closest to the ecological approach is the connectionist neural network model. This does not have representations as intermediaries. In place of straightforward processes there is the activity of the network settling down to a relatively stable state. The network does not settle completely but is continuously active processing data or possibly modelling information pick up. The activity of the network may be compared to some form of resonance. There is a problem however with the ontological commitments involved with connectionism. The ecological approach rests on its ecological ontology and cannot accept that of the commonplace approaches it opposes and rejects.

Inference is another sort of processing commonly found in accounts of perception. The process of inference requires that two different things come together and produce, that is infer, a third different thing. The ecological approach binds the environment and the perceiver in a reciprocal relationship. Perception is a direct result of this relationship. Given this description and the nature of inference it is not possible for perception to be the result of inference. The ecological approach therefore rejects any description of perception

as the result of inferential processes between objects, perceptual systems, representations, internal transformations and so on.

Processing theories of perception encompass approaches that have in common the view that perception necessarily involves processing of some sort as essential to the description of perception. This category includes many cognitive scientists and philosophers of mind.

Fodor states that the operation of input systems is a mandatory requirement for the process of perception and it is this that removes the possibility of any non-computational account. The computational account stands or falls on its own merits not as an account of perception involving perceivers in environments but as an account of computational processes.

On the processing account if however we suppose that the input into the system is meaningful and the output is meaningful then all the processes in between must be meaningful. There must then be many meaningful processes in cognition but where we are unable to find meaningful conscious processes we postulate meaningful unconscious processes. When challenged we may be inclined to the view that it could work in no other way than the familiar processing way. We may not be inclined to look for an alternative explanation. The ecological approach offers just such an alternative explanation. It is false to assume that the meaningfulness of the input and output implies a set of meaningful processes in between and it is not necessary to postulate in principle inaccessible unconscious processes, see J. Searle, *The Rediscovery Of The Mind*, 1992, chapter 10.

There is also a distinction between perceptual processing and cognitive problem solving. The ecological approach must reject the former but may in its own way accept the latter. According to this distinction perception denotes the recording of information through receptors of physical energy and cognition stands for logical problem solving of some explicit sort.

It is not inconsistent with the ecological approach that there are thoughts which are connected to but not part of certain perceptions. This point may be put by saying that straightforward perceptions such as those involved in walking are delivered by direct perception whereas affordances may allow perceptions to be brought under concepts or may be connected to indirect forms of cognition such as reasoning and memory. Such indirect forms of cognition may involve inferences and other processes.

Information Processing Approaches

The information processing approach seeks to model the act of perceiving by describing it according to the rules of a machine or device such as a computer. The ecological approach though information based neither judges perception in terms of a machine nor a device, nor is it an information processing approach.

Information processing theorists use the term "input" without agreeing on what this input is. Without a definition and a suitable ontology the processes that are supposed to work on the input are metaphorical. They are not subject to observation or measurement. Whatever they are, they are not an account of perception.

Information processing approaches ask how the perceptual input is processed to produce perception. A theory of how perception is accomplished must contain a theory of what is processed. Information processing approaches necessarily embody a statement of what constitutes perceptual information. They assume that the input is non-specific, ambiguous or piecemeal makes a theory of how into a theory of correction, elaboration, calculation and inference. In this way information processing theorists fail to make explicit the philosophical origins of their questions, allowing tradition or language to be the arbiter of the ontological status of hypothesised entities.

The ecological approach stands in contrast to the information processing approach. It reflects philosophical dynamic holism whereas the information processing approach reflects commonplace perceptual theory and in particular dualism and reductionism.

With respect to the brain none of the relevant neurophysiological processes are observer relative though they can be described from an observer relative point of view. With the brain it is the specificity of the neurophysiology that is important. Consider the example where I see a car coming towards me. A standard computational processing model of vision will take in information about the visual array on my retina corresponding to the sentence "there is a car coming toward me". That is not what actually happens. In physiology a concrete and specific series of electrochemical reactions are set up by the assault of the photons on the photoreceptor cells of the retina and this entire process eventually results in a visual experience. The physiological reality is not that a bunch of words or symbols are being produced by the visual system. It is rather a matter of having a specific conscious visual experience.

With computational processing we can make an information processing model of a cognitive event or of its production as we can make an information processing model of the weather, digestion or any other phenomenon. However the phenomena themselves are not thereby shown to be information processing systems.

The sense of information processing that is used in cognitive science is far too abstract to capture the reality of perception and especially perceptual awareness. The information processing described in computational models of cognition is a matter of getting a set of symbols as output in response to a set of symbols as input. It does not capture what it is to perceive. It does not explain how we come to perceive what we perceive.

We may not notice this difference because sentences such as "I see a car coming toward me" can be used to record both the content of the perception and the output of the computational model of vision. This does not obscure the fact that the visual experience is an actual conscious event of a perceiver in an environment.

To confuse perceptual events with physiological processes and computational manipulation is to confuse the reality of perception with a model of perception. The upshot of this is that given the explanatory force of the ecological approach it is false to say that perception involves either computation or processing of any description.

Fodor, Pylyshyn and Ecological Perception

Together Jerry Fodor and Zenon Pylyshyn have attacked the foundations of the ecological approach. Their purpose is to put an end to the idea that direct, non-computational, non-processing models could ever under any description fully explain cognitive processes such as perception. They do not acknowledge the possibility that perception could be explained in an importantly different way to other cognitive faculties, see J. Fodor and Z. Pylyshyn, "How Direct is Visual Perception ?", *Cognition*, 9, 1981.

Fodor and Pylyshyn produce an account of ecological ideas and follow it up with an account of their own ideas. They raise arguments against the ecological approach from a philosophical point of view based on the approach and assumptions of cognitive science.

The ecological approach is not a new variant on psycho-computational theory nor is the ecological approach a naive statement of the immediate seeming facts about perception which may be dismissed by those with a little philosophical insight.

Fodor and Pylyshyn are unhappy with Gibson's use of the term "ecological". Their case is that if there are modifications to perception either processing or ecological ones, and if there is no coherent notion of ecology and in particular if there is no real difference made by the use of the term "ecological" then the modifications required for perception are processes. In this way supposed ecological modifications are ghosts either that or the ecological model is a processing one for Fodor and Pylyshyn there is no approach to perception that is not a processing approach.

The ecological approach holds that no modifications are required and that none take place in normal perception. Moreover, the notion of ecological is well founded and explained at length. The substantial question is whether perception can be direct or whether it must be modified or mediated in some way. Investigating perceptual processes however thoroughly does not address this question.

Before analysing their arguments it should be pointed out that from what they say it is not clear that Fodor and Pylyshyn have understood the ontology of the ecological approach. They do not seem to be aware of the fundamental implications that flow from the ecological reciprocity of the ecological perceiver and the ecological environment. In short they do not seem to appreciate the use of the term "ecological" as set out by the ecological approach and used by ecological philosophy.

Fodor and Pylyshyn focus their work on disproving the notion that there can ever be direct perception. They begin by defining the role of direct pick up in the following way,

"For any object or event x , there is some property P such that the direct pick up of P is necessary and sufficient for the perception of x ".

- J. Fodor and Z. Pylyshyn, "How Direct is Visual Perception ?",
Cognition, 9, 1981, p. 140.

The ecological approach proposes that perception is direct through the pick up of perceptual invariants. The perception of objects as objects requires some further explanation than this formula offers. According to the ecological approach this further explanation is provided by the understanding of affordances.

Fodor and Pylyshyn claim that Gibson's explanation of the directness of perception by appeal to invariants is empty. They take an invariant to be the property of a type of object. For them direct perception is explained by holding that there is a certain invariant property that all and only shoes say, have. This is the property of being a shoe. Direct perception of a shoe is therefore the pick up of this invariant property.

Ecological invariants are not like this. They are, rather, patterns that are selected as unchanging relative to changing patterns. It is by such invariants that something is perceived as individual, objective and as possessing an objective unity of properties. Perceptual recognition involves the perception of an individual as a type of thing by the perception of a set of properties that are invariant to a number of individuals.

Fodor and Pylyshyn take the notion of information pick up to involve the following:

- a) A new notion of perception,
- b) A new account of what there is to be perceived,
- c) An account of the information involved,
- d) A new account of perceptual systems with an account of how they overlap, and,
- e) The upshot that information pick up entails that perception is the articulation of an activity of the system not previously given.

Points a) to c) address issues at the heart of Gibson's concern. Point d) rests on work presented in the SCPS and later modifications. The ecological approach takes much of the SCPS as read and understood but also requires additions and modifications to the views presented there. The SCPS does not present the full ecological viewpoint and so Fodor and Pylyshyn's point e), their upshot, is in danger of criticising a non-computational *and* non-ecological view.

Central to the articulation of points a) to c) are the constraints on the ecological notions of direct pick up and invariant. Ecological notions are well constrained by ecological theory but for certain cases including blindness and

deafness, hallucination and some illusions a careful and exhaustive ecological description of what is actually taking place is required to explain these phenomena. It is not correct to criticise ecological theory by use of cases described in non-ecological terms.

To understand the ramifications of the ecological approach, Fodor and Pylyshyn turn to the notion of perceptual information. Fodor and Pylyshyn examine what this could be, offering discussion of four different readings.

Their first reading states that,

- 1) Only the ecological properties of the environment are directly perceived.

On this reading ecological properties include some properties of the environment which are also properties of objects such as texture, shape, illumination, reflectance and malleability.

Ecological properties also include certain properties of arrangements of objects and especially of surfaces. Surfaces are ecologically important. Being open or being cluttered are ecological properties of the layout of an environment, for example, where an open layout is characterised by ground, horizon and sky only, and a cluttered layout is characterised by ground, horizon, sky and objects scattered on the ground. A layout may have the further ecological property of being hollow or of being enclosed.

Affordances are an important class of ecological properties. Affordances are properties of objects concerning the goals and utilities of an organism such as being edible, being dangerous, being a tool, being shelter and being a mate. Affordances are dispositional properties for they concern what an organism could do. They are relational properties for different organisms can do different things with objects of a given kind. An ecological property is ecological in virtue of being a property of the environment.

Ecological properties constrain the description of the environment. Properties that are not ecological properties of perception are properties that things are not be perceived to have. On the ecological approach perceiving amounts to a telling by looking at hence non-ecological properties such as being made of atoms and being one thousand miles away are not perceptual properties. The problem with this is that unless there is a criterion for being ecological other than being perceptible then the notion of ecologically perceivable is interdefinable with the notion of directly perceivable. If this is true then the ecological approach is open to Fodor and Pylyshyn's charge that it is not properly constrained and therefore offers only pseudo-explanations. There are, however, ecological properties such as certain evolutionary, biological and behavioural properties that are not ecological perceptual properties. These show that Fodor and Pylyshyn's charge is not proven.

Fodor and Pylyshyn's second reading states that,

- 2) Only the projectable properties of ecological optics are directly perceived.

Projectable properties are those expressed by projectable predicates. To say a property is projectable is to say that there are laws about the property it expresses. These projectable laws include all relevant laws about that property. Such laws explain how discontinuities in the light array are connected with the spatial overlap of surfaces of objects in the environment. Another role for these laws is to connect flow patterns in the light array with characteristic alterations of the relative spatial positions of the observer and the object being observed. Gibson presents the latter as a tentative hypothesis involving surfaces and occluding edges.

Ecological properties may be perceptual properties and as such may be picked up directly. Fodor and Pylyshyn propose an independently specifiable subset of ecological properties as directly perceptible. This differs from the procedure of the ecological approach for Gibson proposed ecological laws that connect certain ecological properties with features of the light emitted or reflected by objects in the environment.

Projectable perceptual properties connect properties of ambient light in a lawful way. They approximate to the possible objects of direct visual perception with the provision that not all projectable properties are perceptual properties.

Affordances are directly perceived and yet they are not necessarily projectable. Things which share affordances such as chairs and stools often have a common characteristic such as shape, colour or texture. Things that are sittable on for example may have a seat, that is a surface of the same general shape and orientation. Such common characteristics are connected with the properties of the light that the object reflects. The perception of affordances is not mediated by inference from prior detection of shape, colour or texture and so on.

Fodor and Pylyshyn's third reading states that,

- 3) Only phenomenological properties can be directly perceived.

It is not clear how Fodor and Pylyshyn think the ecological approach is committed to the claim that only phenomenological properties are directly perceived nor is it clear just what they take phenomenological properties, in their sense, to be. It may be they think that sophisticated perceptions must be indirectly perceived and that only raw, phenomenological perceptions are suitable candidates for ecological directly perception. The ecological approach shows that this is not so. Perceptions are what we perceive. There is no "internal" or "low level" *perception* lying behind what we perceive. What we perceive is all the perception there is.

With respect to developmental perception, children learn early to recognise and name certain perceptually accessible properties of the environment.

These are paradigm cases of what is directly perceived. Fodor and Pylyshyn refer to these properties as phenomenological properties. It is however not clear that phenomenological properties are what young children learn as recognisable and nameable as perceptually accessible properties of the world. There are rather fully fledged cases of perceptual information pick up.

The ecological approach enlarges on this distinction with an account of ontogenesis, that is the origin and development of an individual. Here the contribution of E.J. Gibson to the ecological approach is of primary importance. On her account the infant perceiver discriminates between surfaces, lines and curves so picking up their qualities. This gives the infant notice of the affordances of the object and hence a notion of the object itself. An affordance is a giving rather than an inferring. The infant is in no way beholden to Fodor and Pylyshyn's phenomenological properties alone though it may be that such properties play a role in ontogenesis, see PPLD, 1969.

The ecological approach has a wider notion of direct perception than Fodor and Pylyshyn allow. The ecological perceptual environment has been described in meaningful terms. It is full of perceptual information. It is organised in a way that allows perceptual information pick up. Bare phenomenological properties fall short of the ecological description of direct perceptual information pick up from the environment even when considered only in relation to the needs of the observer. It is here that the ecological distinction between perceptions and sensations shows itself. Perceptions are qualities of the world in relation to the needs of the observer. Perceptions are cases of direct perceptual information pick up. Sensations are incidental to the needs of the observer. They are what is triggered by light, sound, pressure and chemicals.

Fodor and Pylyshyn's fourth reading states that,

- 4) Whatever is directly perceived is whatever a perceptual system responds to.

The specification of a perceptual system is constrained by the specification of direct perception. For example the retina responds only to properties such as the wavelength and the intensity of light. This means that other properties of light and visual properties of distal objects are apprehended indirectly. This is not part of the ecological approach. The ecological perceptual system for vision is the entire complex of lens, pupil, chamber and retina, as well as the eye, its orbital muscles, the two eyes in the head, the eyes in a mobile head, the eyes in a head on a body and the eyes in a head on a body in the environment. This ecological outlook leads to the conclusion that what perception is able to detect is determined by the discriminative capacity of the system.

Given this, it may then be suggested that the ecological approach ought to include in the description of the visual perceptual system all the connections between each and every part involved or at least the parts that turn out to have causal efficacy. The ecological reply to this move is to say that,

- a) These points are given due account in the ecological description of the place of the body in perception and the explanation of the senses as perceptual systems, and,
- b) The argument of the ecological approach is ecological and functional, not anatomical and physiological, and reciprocal and resonant, not linear and causal.

For Fodor and Pylyshyn there cannot be lawful relations between organisms as epistemic agents and their environments. They do not think that any psychological theory can be grounded in laws of nature although they admit that if affordances were lawfully specified in ambient light then direct visual perception of affordances would be possible.

Fodor and Pylyshyn conclude that the ecological approach is trivial because it is unconstrained in principle. In this way Fodor and Pylyshyn claim to have blocked an ecological investigation of perception and cognition.

The point of view Fodor and Pylyshyn address and attack is not the mature ecological approach. There are an abundance of principles in the ecological approach both for perception and for cognition. Those for perception are rigorous and constraining and are neither inferential nor self-referential. Our experience of perception and cognition is entirely unlike the symbolic analyses proposed by Pylyshyn and others. Indeed the ecological approach has already spawned a scientifically tractable approach to cognition, practised among a flourishing community of ecological psychologists, see for example M. Turvey, R. Shaw, E. Reed, and W. Mace in "Ecological Laws of Perceiving and Acting : In Reply to Fodor and Pylyshyn (1981)", *Cognition*, 9, 1981.

Chapter Fifteen: Cognition and Mind

Cognition and the Ecological Approach

The ecological approach to cognition differs from that of contemporary philosophy and psychology. According to the ecological approach, cognition may be direct like perception or indirect like memory and reasoning. These are not physical phenomena. Though the ecological approach does not reject the notion of cognition there is no role for cognitive processing or non-perceptual cognition in ecological perception. On the ecological approach there is no such thing as processed perceptions. The product of any such processing cannot be a final or real perception.

The ecological approach also rejects the idea that cognition is tagged on to raw data or perceptual input at some later stage in order to deliver perception. Perception is ecologically direct. The ecological approach to perception stands in its own unique relation to cognition and other cognitive faculties.

Cognitive processing is often thought necessary to account for perceptual knowledge. The ecological approach holds that knowledge of the environment develops as perception develops, extends, becomes finer and is enriched. This sort of knowledge comes from seeing, hearing, touching, smelling and tasting. It is perceptual knowledge. Knowledge is also acquired indirectly from many other sources such as parents, teachers, pictures and the linguistic media. This is not perceptual knowledge though it may be knowledge about perception.

The ecological approach has implications for the study of cognition for example in the debate between the realism of cognitive science and ecological realism. This asks if the uniformities observed in nature are expressions of an underlying coherent framework of laws or if such uniformities are the inventions of the human mind applied to nature by one cognitive faculty and interpreted by another cognitive faculty. With respect to the uniformities of perceiving and acting non-ecological approaches are inclined toward prescribing to nature, that is to the perceiver and the environment rather than to the mind.

The explanation of perceptual capacities requires an account of the place of the organism in its ecological niche. A reciprocal relationship between organism and ecological niche alone does not support a contention that perception is in no way cognitive. A species may evolve cognitive capacities as well as capacities of other sorts. These may evolve because they play a role in the pick up of information useful for the survival of individuals of the species. Such a relationship serves to illustrate the sort of cognitive abilities there are and to suggest the sort of cognitive abilities that may develop.

With respect to perception this relationship is indicative of direct, non-processing abilities.

Lower organisms are held to have perceptions but not sophisticated cognitive abilities. If these organisms are able to perceive without being supposed to have internal representations and to process cognitive data then there is no reason to suppose that cognitive constructs should be needed for perception in higher organisms. Nonetheless those such as Ullman talk of the interpretation of the observer and of internal representations as necessary processes in perception.

The ecological approach explains the differences in perceptual abilities between naive and informed observers by noting that they are differences in perceptual learning and are not cognitive differences.

A theory of perception that invokes cognitive operations as a result of perceptual stimulation must also incorporate the view that perception involves the enrichment of sensory inputs, the construction of percepts and other sorts of internal representation.

The ecological approach holds that perception is direct. It must therefore explain the relation between direct perception and indirect cognition. It must explain if perception is in any sense cognitive and if not then how perception and cognition are separable.

Ecological information pick up is direct. It requires intelligent, purposive behaviour on the part of the perceiver. The question is whether a complete account of this activity delivers perception or whether it stops at the level of head, eye and body movements and requires cognitive intervention in order to produce perception. This is not a matter of biological or physiological enquiry for the physical make up of the perceiver is qualitatively distinct from the perception of the perceiver.

John Heil takes up the point of view of those who find it hard to see how theories of perception framed in terms of information pick up can avoid some mention of cognitive occurrences. An organism that has picked up information of a certain sort differs from a creature that has failed to pick up that information. Organism and environment reciprocity does not alter this fact. We may disagree about how to regard psychological goings on but that a theory of perception must incorporate some reference to such goings on is required. If perception provides a creature with information about its surroundings then an organism's possession of information has to be a psychological fact about that creature.

Heil's criticisms force ecological ideas into a non-ecological framework. Heil insists that the issue is whether one can account

adequately for the pick up of information without involving cognitive factors such as concepts, in addition to perception. Heil's position is that to leave out the additional cognitive factors is to leave a gap in the explanation of perception. For him an account of perception which does not feature these additional cognitive factors is incomplete in principle, see John Heil, "What Gibson's Missing", *Journal for the Theory of Social Behaviour*, 9, 1979.

For Heil a necessary part of a theory of perception is the setting out of conditions that determine the pick up of information. These are factors influencing the content of an organism's perceptions and their acquisition of perceptual beliefs about the world by way of their senses. Heil suggests that no theory of perception can ignore the cognitive contribution of the perceiver and focus solely on the perceiver's biological endowment and certain properties of the environment.

This suggestion is false for the ecological approach characterises the content of a perception as the information the perceiver has picked up, and the object of that perception as the information available to a perceiver whether picked up or not. With these notions of perceptual content and perceptual object the ecological approach is able to account for the fact that different perceivers have different perceptions in the same environment without recourse to any indirect cognitive processes. The same environment holds the same information, the same structured optic array, for all perceivers but due to evolutionary and ecological considerations, the information each sort of perceiver picks up is not the same. A sailor and an albatross may see the same sky. This account applies within the same species too. An infant looking at a carburettor does not see what an accompanying car mechanic sees. The information picked up by each perceiver is part of the total information available in the environment. In this way each perceiver is able to perceive different parts of their environment. The ecological account is cognitively complete and involves nothing cognitive beyond ecological perception – no more and no less.

Reed and Jones take Heil's suggestion that perception requires additional cognitive factors to be a demand for the acquisition of information with perceptual learning. Perceptual learning is accounted for by the ecological approach. The question here is not whether these learned abilities can be characterised without reference to cognitive abilities but whether the learning of these abilities is perceptual and whether that this learning can be characterised without reference to further cognitive abilities, see E. Reed and R. Jones, "Is Perception Blind ?", *Journal for the Theory of Social Behaviour*, 11, 1981.

The ecological approach says much about the role of cognition and learning in perception. It does not shunt aside issues concerning the

functions of experience and knowledge in perceiving. Perception and perceptual knowledge are direct. They may be described as direct cognition. Other cognitive faculties and processes are indirect. They may be described as indirect cognition. Indirect cognition is no part of ecological perception.

Cognitive Science and the Ecological Approach

Cognitive science involves itself with the explanation of cognition and the methods of science. It investigates perceptual and cognitive systems through the empirical investigation of empirically testable physical phenomena. This involves the formulation of mental models of the same form as and which are supposed to play the same role as the physical models of empirical science. In this way cognitive science makes claims about how mental and physical systems account for cognition. Cognitive science holds the investigation of these systems to be the investigation of the phenomena of cognition themselves. To do this cognitive science holds that mental processes involve computations defined over and above mental representations. Cognitive science is therefore mentalistic and dualistic. Mentalism and dualism shape and form the ontological picture and commitments of cognition and mind. Cognitivist and constructivist approaches impute mentalistic models to dualistic theories that structure and interpret sensory information. They claim that perceivers compute reality and do not detect it or pick it up.

Many thinkers, philosophers, psychologists and ecologists included, reject the approach of cognitive science. Some reject the idea of mental models. Others reject cognitive dualism. The ecological approach denies the dualism of mind and brain and so denies the usefulness of such mental models.

The ecological approach takes cognition and the cognitive systems to be separate and distinct phenomena. They are to be explained in different ways. Cognition is not to be explained by what goes on in the head whereas cognitive systems may be explained at least in part by what goes on in the head. This stands comparison with ambulation and ambulatory systems. Walking is not to be explained by what goes on in the legs whereas the ambulatory systems may be explained at least in part by what goes on in the legs. Cognition and walking stand comparison for they are functions of animals. Both may be analysed functionally in terms of the animal. It is not correct to explain functions of the animal in terms of what goes on in the head nor is it correct to explain what goes on in the head in terms of functions of the animal. Like is to be compared with like. In particular functions of the brain are to be explained in terms of functions of the brain.

The directness of ecological perception involves the rejection of the story told by cognitive science of how vision constructs three

dimensional mental models and of how personal knowledge is used to make unconscious inferences that are able to identify objects.

The disagreement between the ecological approach and the computational approaches of cognitive science is over the function of the sensory organs or systems. It is not over the existence, anatomy or structure of them.

Cognitive science aims to discover complex patterns such as those found in perception or language and then to postulate combinations of mental representations that will explain the pattern in the appropriate way. Where there is no conscious or shallow unconscious representation cognitive science postulates a deep unconscious mental representation. Epistemically, the existence of the patterns is taken as evidence for the existence of the representations. Causally, the existence of the representations is supposed to explain the existence of the patterns. Both the epistemic and the causal claims presuppose that the ontology of deep unconscious rules is perfectly in order as it stands. If it is not in order then both the epistemic and the causal claims collapse together.

From an epistemological point of view both plants and perceptual systems exhibit systematic patterns but this provides no evidence at all for the existence of deep unconscious rules.

From a causal point of view the pattern of behaviour plays a functional role in the overall behaviour of the system but the representation of the pattern in a theory does not identify a deep unconscious representation that plays a causal role in the production of the pattern of behaviour because there is no deep unconscious representation. This holds in general, that is as much for perceptual systems as for plants.

The ecological approach does not seek to solve the difficulties of cognitive science and cognitive processing in cognitive terms. The ecological approach shows that what cognitive science undertakes is not what cognition is about at all. A study of the ecological environment and the function and role of the organism in this environment shows the actual, ecological nature of cognition. With its descriptions, accounts and explanations the ecological approach speaks to the problems and of perception and the mind in its own, ecological way.

The Ecological Approach and the Mind

On the ecological approach the nature of mind and mentality is related to the issue of the role of the perceptual systems and activities of perceivers in environments.

Explanations of the mind and the nervous system commonly rest on a dualistic theory of mind and matter. If order, organisation and integration are localised in the perceiver then constructive and representational processes seem to be necessary to explain mental and neural functions. If this dualist bifurcation is abandoned then the functions of mind and neurology can be conceptualised differently. Such a conceptualisation is just what is achieved by the ecological account.

Historically there has been a theoretical gulf between the physics of objects in space and the presumed meanings of things. The structural and compositional ecology of opaque solid geometry and substances differs considerably from the physics of objects in space. Many animal related functions are tied to this ecology ; openings afford locomotion, cliffs afford jumping, occluding edges afford concealment, objects afford throwing, holding, plugging and so on.

The ecological approach goes beyond those phenomenologists who have attempted to ground the human sciences in a concept of value and has developed a concept of value as external to, though not separate from, the observer. With its description of the environment of one and of all observers the ecological approach is able to show that affordances are facts of the environment of all observers that can be used by particular observers. They are not to be understood as relations between two things. As environmental facts, affordances are real and external. They are not mere possibilities. An apple is a real food object, even if uneaten and even if it does not afford eating to a goldfish. Instead of conceiving of mental facts as potential courses of action, as many philosophers and cognitive psychologists have done, the ecological approach conceives of mental life as the awareness of affordances of the environment.

The more the world has been examined the less comprehensible mind has seemed. With the ecological approach mind is given a place in the world not alongside the complex physical relations of the brain and the universe but amidst and amongst perceivers and environments. On the ecological approach mental life is the ability of an organism to experience the environment and to act appropriately on this experience.

Chapter Sixteen: Ecological Completeness

The ecological approach is often accused of being incomplete in some way. The suspicion is that the ecological approach offers insufficient analysis in several areas such as physiology, computation and inference to give a full account of perception.

The ecological approach is unlike any commonplace account of perception. It includes no physiological experimentation. It offers no computational account. It does not involve an explanation of perception that involves inferences. Critics may then conclude from this that the ecological approach must be incomplete. The alternative is that physiology has no place in the account of perception itself, that there is no computational account of perception and that no inferences are involved in the account of perception. This alternative is delivered by the ecological approach.

The epistemology of the ecological approach has been accused of incompleteness. This objection stems from Jaakko Hintikka's criticism of psychology in general for hasty epistemologising. By this he means the unwarranted transfer of ideas from psychology as a discipline dealing in questions of fact into epistemology as a discipline dealing with questions of method and theory, see J. Hintikka, "Information, Causality and the Logic of Perception", in *The Intentions of Intentionality*, 1975, pp. 59 to 75.

David Hamlyn takes up Hintikka's point and applies it specifically to the ecological approach arguing that the ecological direct perception is an example of such an inappropriate transfer, see D. Hamlyn, "The Concept of Information in Gibson's Theory of Perception", in *Journal for the Theory of Social Behaviour*, 7, 1977.

In this way ecological theory is incomplete for it is not able to provide an account of the chain of occurrences leading from retinal stimulation to the perception of the world. Hamlyn agrees with Gibson that the need for such an account is grounded on epistemological assumptions not taken up or warranted by the ecological approach. Hamlyn does not agree with Gibson that such epistemological assumptions are unnecessary and irrelevant.

Hamlyn's supposed incompletenesses show up as differences between ecological theory and other theories. In particular Hamlyn asks for an analysis of the relation between information getting and sensation and intimates that Gibson has no theory of information processing. But Gibson has both a theory of the relations of sensation to perception, that is information pick up, and a theory that accounts for what Hamlyn demands from perceptual processing, namely perceptual resonance.

Reed and Jones argue that Gibson answers Hamlyn's questions in a way so radical that it throws doubt on the validity of Hintikka's distinction between psychology and epistemology. They maintain that the ecological approach is a valuable source of both epistemological and psychological ideas and that a perceptual psychology which correctly applies ecological epistemology is able to explain many problems in psychology, see E. Reed and R. Jones, in "Gibson's Theory of Perception : A Case of Hasty epistemologizing ?", *Philosophy of Science*, 45, 1978.

This reply does not satisfy John Heil who objects that Reed and Jones have missed his point. The incompleteness ascribed to ecological theory by its critics cannot be eliminated by simply embracing Gibson's version of direct realism for the ecological approach is both epistemological and empirical asking many questions and raising many problems as well as offering new explanations and solutions. In taking direct realism to be a concrete position Heil claims that Reed and Jones rely on epistemological assumptions that Gibson explicitly rejected, see J. Heil in "What Gibson's Missing", *Journal for the Theory of Social Behaviour*, 9, 1979.

Heil's objections come to the following three claims,

- 1) Gibson has not said enough about the process of extracting information from the ambient optic array,
- 2) The ecological account of information pick up lacks any discussion of perceptual learning and in particular the differential perceptual abilities of persons with different histories constitutes a gap in ecological theory,
- 3) Perceptual learning must implicitly involve associating concepts with percepts, for instance matching knowledge of what a thing looks like to current perception.

According to Heil, Gibson has neither fully explained nor explained away the task of investigating properties of the perceptual system which make possible a given kind of use of the perceptual information available to it at a given time. This point was met by Harry Heft. Heft says that what Heil points to as a gap in Gibson's thinking is rather a failure on Heil's part to fully understand the perspective that Gibson offers. The gap Heil points to is a result of evaluating Gibson's position from a perspective Gibson explicitly rejects. In ecological terms there is no gap at all, see H. Heft, "What Heil is Missing in Gibson", *Journal for the Theory of Social Behaviour*, 10, 1980.

Heil criticises Gibson for failing to provide an account of the nature of information pick up and therefore finds the ecological theory

incomplete. For Heil an adequate theory of perception must provide both a description of the information to be perceived together with a full description of precisely how this information is extracted. Heil claims that Gibson has not said enough about the process of extracting information from the ambient optic array. This omission is apparent in the problem of individual differences in information pick up, that is in accounting for cases where one person extracts information from the ambient optic array while another does not such as over the diagnosis of an x-ray. For Heil such differences must be accounted for with reference to information pick up. As Gibson has not articulated how information is extracted from the optic array so he has not explained these differences. Heil concludes that Gibson has failed to explain the process by which information is extracted.

The ecological approach uses four main sorts of explanation; evolutionary, functional, descriptive and developmental. Heil has failed to recognise these four forms. The problems with the nature and role of information pick up that Heil refers to are answered by the ecological account of cognition and in particular by the comparative roles of invariants and affordances in information pick up. Furthermore, Heil's account of ecological perception omits the notion of perceptual resonance. It is perceptual resonance that accounts for how perceivers interact with the optic ray. It is then Heil's account that is incomplete and not the ecological approach itself.

Heil does not take the ecological approach on its own terms. Heil considers the ecological position from the perspective of animal-environment dualism. This construes the animal and the environment as logically independent and consequently as subject to independent analyses. From the perspective of animal-environment dualism, ecological optics appears only as an alternative to the standard types of descriptions of the environment. As a description of the environment it omits any account of the perceiving processes of the animal. Animal-environment dualism is not part of the ecological approach. The ecological approach is far more than an alternative description of the environment. The ecological approach provides an alternative conceptualisation of the relationship between the animal and the environment. This approach which rejects the assumption of animal-environment dualism, see M. Turvey and R. Shaw, "The Primacy of Perceiving" in L. Nilsson (editor), *Perspectives on Memory Research*, 1979.

Once ecological information and affordance are understood as reciprocal, pointing both to the animal and to the environment, Heil's concerns about perceptual pick up may be answered.

The individual differences of information pick up are accounted for by the ecological nature of perceiver and of the environment. Ecological information is reciprocal and resonant and so differences among

perceivers can be accounted for both in terms of a specification of what is perceived and in terms of how this information is picked up.

Perceptual pick up differs because perceivers are differentially sensitive to information. This sensitivity can be described with reference to the informational structure in the ambient array. Perceivers may employ different exploratory actions of the eyes, head and body to facilitate the isolation of invariant structure in the ambient array. Sensitivity to informational structure and actions which are involved in information pick up are not distinct functions but reflect the workings of a unified perceptual system.

The affordance properties of the environment are defined with respect to an individual's capacity for activity. Pick up of information specifying an affordance is a function of the characteristics of the perceiver. In general information that is ecologically commensurate with the observer is more easily picked up than information that is alien or strange to the observer.

Individual differences among perceivers can be examined with regard to the dimensions of sensitivity to informational structure in the environment, exploratory activity and the attributes of the body. These dimensions account for individual differences in perceiving without reference to the inside of the perceiver.

Heil's conclusion that Gibson is missing an account of the processes involved in using perceptual information has no force for his claim rests on the very sensation based view of perception that the ecological approach was designed to throw out. To take issue with parts of the ecological theory in terms of a sensation based view of perception is to show a lack of understanding of the nature and purpose of the ecological approach, see E. Reed and R. Jones, "Is Perception Blind ?", *Journal for the Theory of Social Behaviour*, 11, 1981.

Completeness and Sensation

The ecological approach has been accused of not presenting a full explanation of the role of the senses and sensations in perception. Gibson wrote and published an essay devoted to investigating the relations of sensation and perception. This was "The Useful Dimensions of Sensitivity", *American Psychologist*, 18, 1963. Here Gibson offers a theory about the relations of sensation to perception which holds that classical sense impressions are something of which only an adult human thinker is aware. These sense impressions tend to arise on introspection or when describing the content of experience, or when simple variables are experimentally isolated by a psychologist, or when stimuli are applied to receptors instead of being allowed to obtain for the whole perceiver. Far from being

original experiences they are sophisticated for they depend on a great deal of past experience.

The SCPS is devoted to the sense, the perceptual systems and the mechanisms involved in the pick up of information. It sets out the theory that perception is not based on the having of passive sensations or stimulations but on the active pick up of meaningful information from the environment by the perceptual systems of organisms. It accounts for the utilisation of information not in terms of perceptual receptors but in the terminology of motor and action physiology.

In this way Gibson distinguishes the ecological information based approach from sensation based theories. These latter theories usually begin with the retinal image and attempt to explain how this is transformed, converted or processed to yield the perception of three dimensional scenes, objects and events. Such a view of perception comes not from empirical studies of perceptual processes but from an assortment of epistemological assumptions advanced by philosophers who take our perceptual contact with the world to be indirect, mediated by percepts, sensa, sense data and so on. Such sensational entities lack many of the properties possessed by objects and events in the world such as constancy, unity and three dimensionality, all of which must be added, imposed or inferred by mental operations. Hence the task of perceptual theory is to describe mental operations which may be related to the nervous system.

In addition it should be pointed out that though proponents of sensational theories, and suchlike, may disagree with one another this does not mean that they do not make the assumptions rejected by Gibson and shown wrongheaded by ecological philosophy.

Ulrich Neisser and others have addressed the question of whether Gibson's rejection of sensation based theories of perception is a source of incompleteness in the ecological approach, see U. Neisser, *Cognition and Reality*, 1976.

Now, Gibson rejects sensation based theories and their concomitant epistemologies for on the ecological approach visual perception begins with the pattern of ambient light reflected from the surfaces of objects and not with retinal images or sensa.

On the ecological approach our perceptual systems have evolved to pick up and resonate with invariants which specify objects and events. What we perceive are not invariants but the objects and the events that the events specify. Perception is the extraction of information from the world not the construction of an internal world. The information to be extracted is in the light reflected from objects and events in the world and not in our retinal images or in our visual cortices.

This is a version of direct realism. The role of perceptual mechanisms is to extract information not to convert retinal stimulation into internal representations of external states of affairs. Perception is not mediated but is in this sense direct. The ecological approach has no gap between the objects of our awareness and the environment which we inhabit. This environment is what we perceive, it is what we are aware of and this perceptual awareness is dependent on the proper functioning of our perceptual systems. This fact is not evidence for the view that what we perceive is the indirect product of neural activity.

On the ecological approach there is no gap between sensation and perception to be filled. Gibson's refusal to postulate perceptual mechanisms designed to bridge such a gap is not an oversight. It is the logical consequence of adopting the ecological approach to perception in particular and the ecological approach in general.

Completeness in the Philosophy of Perception

If the ecological approach omits what is essential to perception then the ecological approach as a whole is undermined. The ecological approach however omits only terms and assumptions from ideas and theories it opposes. Its critics often fail to account for Gibson's fundamentally different epistemology, one that is ecological in character and based on evolutionary consequences. Such critics offer an analysis of the ecological approach as a variation of the dualism that underlies their own accounts and usually without any attempt to argue that the ecological position is such a variation. For instance many perceptual researchers take unconscious and sub-personal mental activities as phenomena to be accounted for by a theory of perception. The ecological approach regards these entities as creations of the imagination, the consequence of a flawed ontology and epistemology, see S. Wilcox and S. Katz, "What Gibson Isn't Missing After All", *Journal for the Theory of Social Behaviour*, 11, 1981.

The ecological approach goes beyond description. In the ecological approach evolution, development and intention are intertwined. On the ecological approach organisms perceive the world directly. Perceptual systems have evolved in relation to the organism's particular needs. Since different organisms have different modes of action they perceive things differently.

This principle is relevant at both the phylogenetic (evolutionary type) level and at the ontogenetic (evolutionary token) level. A species develops its ways of perceiving in conjunction with its modes of action through its evolutionary history. An individual develops their ways of perceiving in conjunction with their personal modes of action through their personal history. Thus an eagle but not a sparrow can

see a rodent from three hundred metres, the chess grandmaster but not the novice can judge an endgame after a handful of moves. This is because of their past evolutionary histories and because of their present ecological needs, purposes and intentions.

Though mechanistic explanations are not ruled out by the ecological approach they are rarely offered by Gibson. The ecological approach takes it as given that perceptual differences correlate with physiological differences and with the overt actions which play a role in perceiving. But for perception it is not necessary to understand these any more than it is necessary to understand the internal combustion engine in order to be able to drive. It depends on one's purposes. Brain surgeons and physiologists need to learn about the nervous system. Perceptual theorists need not concern themselves about such issues.

From these considerations an ecologically complete philosophy of perception requires,

- a) A suitably general account, and
- b) An account rich enough to explicate perceptual differences among species and among individuals within species.

For cognitivists, such as Heil, a complete philosophy of perception requires three components,

- 1) Something to be perceived,
- 2) A perceiver, however endowed, and
- 3) Various cognitive capacities of the perceiver.

These allow a perceiver to perceive some things cognitively directly or as Heil says "just by looking".

Heil's expressed commitment to non-ecological accounts is reinforced by his views about the relationship between the environment and the perceiver, and about the relationship between perception and cognition. Heil's account of perception requires a cognitive element. This requirement is explicitly denied by the ecological approach and as such Heil's analysis of the ecological approach is not valid, see John Heil, "Gibsonian Sins of Omission", *Journal for the Theory of Social Behaviour*, 11, 1981.

The ecological approach is distinctively ecological because it eliminates the gap between perception and the environment, and between percepts or *sensa* and the external world. If perception is direct then there is no need for the interpretation of perceptual inputs

or the construction of percepts, internal representations and the like for there are no such inputs, constructions or representations.

The alleged gaps in the ecological approach arise from an attempt to judge it in terms of a non-ecological philosophical framework that it has rejected and has offered a complete alternative to. If for instance the critic accepts the non-ecological epistemological assumption that percepts without concepts are blind then they cannot go on to argue that the ecological approach is incomplete because it does not account for issues derived from that assumption. The ecological approach is complete in its own terms and has scope for much addition and development within those terms.

CONCLUSION: The Place of Ecological Philosophy

The ecological approach springs from the desire to learn how organisms are aware of the world. This involves the task of explaining how organisms come to behave as if the world were sensible and meaningful in a regular way. This has concomitant serious and important consequences for philosophy. Ecological philosophy, for instance, provides arguments in opposition to cognitivism, for cognitivism requires the postulation of mental representation from sensory input, while leaving room for the cognitive faculties. Ecological philosophy evades dualism and counters dualist explanations by denying the separation of perceptual experience from the physical world. Ecological philosophy as a whole approach develops a new way of describing perceptual stimulation in terms of information pick up and in this way denies sensations a place in the explanation of perception.

Historically, the starting point for ecological philosophy is Gibson's ecological approach to perception which states that the useful dimension of animal sensitivity is the structured energy that invariantly specifies properties of the environment of significance to that animal. The theory of the ecological approach centres on this premise.

The ecological approach requires that perceptual information be unique and specific to its particular source. It has to enable the perceiver to pick out just that particular source. This information has to be in the correct form for the particular perceiver. The ecological description of the animal-environment relation allows for this direct ecological realism.

The mutual compatibility between animal and environment provides necessary support for the realist claim that animals come to know the real world by perception. It undercuts arguments against veridicality as it demands a description of information that is specific to the environment as it relates to the animal rather than a description in the neutral variables of regular physics. It makes the

question of error in perception a matter of perceptual explanation. Perception is deemed successful insofar as it guides activity because acting in an environment is knowing that environment. Judgements that an error has occurred come from biases about what is happening or can happen in perception.

Evolution delivers the rationale for the reciprocal animal-environment fit of the ecological approach and the grounding for the tenets of ecological philosophy. In particular it guarantees that perceiving, acting, knowing and reality are compatible. Perceiving, acting and knowing are not a matter of making propositions about the environment. They are states of affairs and as such can be neither true nor false but either exist or do not exist. As the physical characteristics of an animal stand in an adaptive relation to the environment so do the psychological characteristics or knowings of that animal. One is not a proposition about the other. Knowing is related to meaning and the ecological approach accounts for both in an animal specific way.

The ecological approach is not a theory to compete against and stand alongside other theories on the basis of the best fit with the results of various sets of planned experiments. The ecological approach is a matter of definition and redefinition. It is not a matter of description.

The ecological approach is a new picture of perception. It is not a new theory within an old picture. It is independent of confirmation or falsification by that old theory. Hypotheses are formed, experiments are confirmed or falsified and theories are developed all within the ecological approach.

A picture in this sense includes a framework of pre-theoretical assumptions. A picture influences more than one theory and more than one type of theory. The terms in which a picture can be attacked are not the same as the terms in which a theory can be attacked. With a theory part may be retained and part rejected. To apply such terms of evaluation to a picture makes no sense. A picture provides the background and the resource for such criticism and attribution. To affect the picture the fact must be about that picture. There are many facts, ideas and hypotheses that stand free from direct connection to the picture.

The best way to change the acceptability of a picture is to present a new, different picture in which the problems of the old picture do not occur. This is what Gibson means by stating that with the ecological approach to perception the traditional problems of perception are problems no more. To ask for the answers to the traditional problems is to ask for the wrong thing. The correct way to approach the problems of perception is to look at the picture of perception as a whole.

The problems of the ecological approach and their solutions are to be found in the relationship between the organism and the environment. The general theoretical method is to identify the information that supports the ecological phenomenon and to determine how that information is detected.

That the ecological approach is a new picture rather than a different theory has allowed many philosophers, psychologists and other theorists to ignore the ecological approach and to continue with dualism, constructivism, sensationalism, computation and so on with ever more sophisticated proposals about the same old problems.

That such thinkers are unwilling to accept Gibson's ecological approach means that they would rather face an endless series of anomalies than abandon certain commitments such as dualism that underlie their thinking. If for instance it must be the case that perception is based on stimuli then it cannot be the case that seeing involves sampling the surrounding perceptual environment. Further, the mentalistic and mechanistic model of vision leads away from common sense for what is found to be true in one domain such as that for pattern recognition is found to be false in others such as motion perception. In this way more and more anomalous phenomena are being created.

Even success is not all it may seem. Postulated lower level processes have been shown to have high level consequences and certain high level processes have been shown to have lower level consequences. On this basis intricate experimental predictions have been made and tested with for example the olfactory mode of perception. Yet the inability of these theories and procedures to explain everyday phenomena, such as smelling food, is ignored.

Non-ecological accounts of vision cannot explain the fundamental perceptual fact of visual awareness, that is how we see a unified world full of meaningful ecological realities. Non-ecological theorists continue to be baffled as to why something which has not produced an account of visual awareness will not produce an account of visual awareness. The ecological approach faces no such difficulty, meeting the challenge of perceptual awareness with the doctrine of perceptual resonance backed up by a full ecological ontology, see R. Haber, "Perception", in S. Koch and D. Leary (editors), *A Century of Psychology as Science*, 1985.

To accept the ecological approach is to relinquish the idea that the mind is something in the head with its cause outside of itself. It is to address the idea that we do not perceive stimuli or the results of stimuli emitted from objects but rather that we perceive information from the environment that surrounds us. In this way we are able to perceive the significance of objects, events, places and people. We

find ourselves in the midst of a meaningful world; a world which we understand imperfectly. We do not confer meaning upon the world as if we already knew our task. The importance of this has been clearly understood and accounted for within the discipline of psychology, see E. Reed, *Encountering the World*, 1996.

Likewise, we now have the opportunity do undertake ecological projects in philosophy and other disciplines. The task of ecological philosophy, then, is to understand more about the world in order to learn more about ourselves and what we seek in our world. This is how Gibson understood both the task of the perceiver and the task of the student of perception.

The ecological approach has scope for development and exploration in many areas and in many ways, including social theory, parenting and architecture. Within the ecological approach there are theories, descriptions and explanations which are themselves testable, acceptable and rejectable both in their own terms and relative to each other. In turn ecological philosophy, set within the ambit of the ecological approach, explains the importance of empirical and biological considerations to philosophy. It promises much, offering as a beginning the exciting, new and fruitful philosophy of perception and of mind that has been set out here.