Nudging the House of Cards: brain physiology and critical consciousness.

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NUDGING THE HOUSE OF CARDS:

BRAIN PHYSIOLOGY AND CRITICAL CONSCIOUSNESS

A Dissertation Presented

By

GAIL S. von HAHMANN

Submitted to the Graduate School of the University of Massachusetts in partial fulfillment of the requirements for the degree of

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Education
NUDGING THE HOUSE OF CARDS:
BRAIN PHYSIOLOGY AND CRITICAL CONSCIOUSNESS

A Dissertation Presented
By
Gail S. von Hahmann

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DEDICATION

To Ernst and Marie, Hazel and Rollie, Roberta and Von, Hazel Mary, Milton, Louise, Karl, Bryan, and Kraig.

and

To Anne Janeway.
ACKNOWLEDGMENTS

First of all, I express my very deep gratitude to Horace Reed, James Crotty and David Kinsey for their patient guidance and faith in the learning process they demonstrated as my committee members.

I sincerely thank Debbie Tomasi and Barbara Gentry for their flexibility, understanding and unusual competence in working technological miracles; and I thank Roberta von Hahmann for her remarkable illustrations.

To friends and fellow learners of the past decade at The Experiment in International Living and its School for International Training and at the Center for International Education at the University of Massachusetts I express my appreciation for generating the experience and reflection which led to the writing of this paper.

Thank you also to the Foundation and its coordinator, Rona Wilson, for the presents and animation I received throughout the long haul.

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Finally, my deep gratitude to Bobby and Marks, without whose help this project could not have been completed.
For human beings, consciousness has both an illusory function and a critical function. The illusory function allows us to see rocks, trees, sky, animals, other humans instead of a constantly changing fluctuation of subatomic particles. While important in helping us adapt to our environment (and in evolution), the illusory function causes us to see what we expect to see, to think what we are used to thinking, to be habitually reactive rather than creative. The critical function, on the other hand, can help us to break out of habit, to be aware of the whole picture by looking for the unexpected and thinking in new ways. For most of us the critical function is overwhelmed by the illusory function as a result of living in social systems which are not self-conscious. The underdevelopment of critical consciousness in today's societies, both industrialized and industrializing, has led to the atrophy of the individual's self-conscious capacity to choose and, subsequently, to the relinquishing of decision-making power at both the personal and political levels.
The study proposes that the development of critical consciousness requires the self-conscious capacity to choose, and that self-consciousness depends upon the training and use of our innate intuitive capacity. Further, the study presents physiological evidence for the role of intuition in developing the critical function of consciousness. Chapter II describes the need for a new paradigm within which to understand this aspect of consciousness which has remained "hidden." Chapter III emphasizes those aspects of brain physiology which underlie our intuitive capacity. Chapter IV describes how it is possible for us to become more self-conscious about our thought and action through training this capacity. Finally, specific skills in introspection are described for use in educational settings.
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CHAPTER I

INTRODUCTION

I consider the fundamental theme of our epoch to be that of domination—which implies its opposite, the theme of liberation, as the objective to be achieved (Freire, 1970, p.93).

Background

Motion and change are constant in the universe, in human social systems, and in the brain of each individual. Often it is this very constancy of motion and change, and its great speed, which helps things to appear not to change, which helps to create the illusion of stability. The wooden table which is also a mass of moving atoms, the social system of capitalist democracy which is mass of fluctuating smaller systems and individuals, our bodies and brains which constantly regenerate at the molecular level\(^1\) -- all of these phenomena present to us a unique combination of constant motion and stability. It is in fact, through the process of consciousness that such motion and change achieve stability in our minds.

Social change is no exception. Our conscious process helps create the appearance, the illusion, that changes in society occur in given cycles, according to given patterns. Ideas based on this illusion often result in oppressive conclusions, for example, that since there have always been people who live in wealth and people

\(^1\)
who live in poverty, poverty and wealth are "facts of life" and will continue regardless of what we do. The fact is that human action creates social change. This study is based on the assumption that the predominating action in global society today is creating change resulting in the increasing oppression of greater numbers of people, both within the United States and in the rest of the world.

It is a second assumption of this paper that education has a major role and responsibility in preparing people to direct social change in a positive way and that education can and should empower people and help them to develop critical consciousness. The development of critical consciousness is necessary to enable us to monitor and influence this helpful but limiting illusory function of consciousness. And the mechanism through which critical consciousness works to accomplish this task is that of recognizing our self-conscious capacity to make choices.

The Need for Critical Consciousness in Massified Society

The stifling of this self-conscious capacity to choose occurs in many ways. As one example, Paulo Freire, whose theory of critical consciousness this paper supports, suggests that people living in a highly technological society (such as the United States) tend to become "massified" through constant maneuvering by the "truth" of the media and less and less real participation in decision making.

Indeed, an analysis of highly technological societies usually reveals the "domestication" of (the individual's) critical faculties by a situation in which s/he is massified and has only the illusion of choice...(the individual) comes to accept mythical explanations of...reality (Freire 1973, p.34). (Emphasis added.)
This domestication or stunting of self-conscious capacity is explained in detail by Freire when he talks of the "dominated consciousness" of the middle class. He refers to a situation where middle class people are unable to perceive a generative theme of oppression in their own lives due to the inherent contradictions of their class position. He calls this contradiction a "limit-situation" (Freire, 1970, p.92).

As an example we might take the case of inequities which have existed in higher education admissions procedures for women and minorities in the United States. People may begin to perceive that certain higher education admission procedures do in fact discriminate against certain groups; yet they also perceive that action against these procedures most likely would have a negative effect on their own group. They do not take action against the discriminatory procedure because they "know" that "everyone has the opportunity to achieve" in this country and therefore, since the system is fair, the difficulty must lie not with the procedure but with the other group's demands.

In this example, members of the majority group are unable to perceive the totality of the limit-situation: that the higher education system has and does discriminate against certain groups, and that this discrimination may be due in part to the present capitalist structure of our society. In any case, the inability to perceive a total picture of the existence of discrimination and its orgins pro-
hibits a truly self-conscious action in response to the original feeling against the admission procedures. In Freire's words:

...fear of freedom leads them (individuals of the middle class) to erect defense mechanisms and rationalizations which conceal the fundamental, emphasize the fortuitous, and deny concrete reality. In the face of a problem whose analysis would lead to the uncomfortable perception of a limit-situation, their tendency is to remain on the periphery of the discussion and resist any attempt to reach the heart of the question (Freire, 1970, p. 94).

Such "defense mechanisms and rationalizations" we can recognize as racist and sexist tendencies in people's everyday behavior.

The inability to perceive a total picture, to analyze one's own environment, the inability to be self-conscious about one's conceptual framework, prevents us from seeing how our lives are interdependent with the lives of others across class, racial, religious, and national boundaries. We are thus unable to perceive alternative actions which might result in more just and equitable arrangements for all involved. The possibility of choosing whether to be racist or not does not occur to most of us who behave that way.

I believe that Freire's words describing Brazil in the 1950's are applicable in the United States today:

The education our situation demanded would enable (people) to discuss courageously the problems of their context - and to intervene in that context...to reevaluate constantly, to analyze "findings," to adopt scientific methods and processes, and to perceive themselves in dialectical relationship with their social reality...education could help (people) to assume an increasingly critical attitude toward the world and so to transform it (Freire, 1973, p. 34-5).

The illusion of people's participation in our democracy is supported by a reality in which people do not participate due to an inability
to move beyond the limit-situations surrounding us. The maintenance of decision-making power by the few resulting in the inequitable distribution of not only wealth but justice both here and abroad provide the backdrop for this study.

In a social system such as ours which creates such a full illusion of equality of opportunity but which realizes that ideal with less and less effectiveness both here and in the nations it supports, the ability to cut through this illusion, to critically analyze the underlying reality, requires new educational emphasis on skills for self-conscious choice. This kind of empowering education is based on an experiential model which can be directly adapted to include skills for self-conscious choice.

Problem and Purpose - Experience as a Way of Knowing

On the surface, learning from experience is not a problematic concept, nor is the relationship of experience to learning an unexplored phenomenon. For the purpose of this study, the Experiential Learning Cycle (see Fig.1) expresses this relationship most succinctly. That is, experience as action or problem solving is at the core of the learning experience. (I have added the self-evaluation component to this model). The problem remains for society, and for education in particular, to give legitimacy to the notion of experiential learning in all of its phases, that is, to recognize the learner's capacity for becoming self-conscious about every phase in this cycle. This capacity involves reflection, self-consciously choosing, and acting on the basis of choice.
Student participation in real or simulated experience)

1. EXPERIENCE, ACTION, PROBLEM SOLVING

5. QUESTIONS, SETTING OBJECTIVES, PLANNING

(student prepares for experiences based on what he has learned)

2. REFLECTION, DISCUSSION ANALYSIS

(student works alone or in groups analyzing the experience)

Self-Evaluation

4. GENERALIZATION CONCEPTUALIZATION

(student generalized concepts assisted by trainer through lectures, readings & other cognitive methods)

3. INSIGHT, DISCOVERY

(student learns concepts involved in experience)

Figure 1: Experiential Learning Cycle
(Adapted from Peace Corps training materials)
This capacity for self-consciousness is, I believe, what makes praxis possible. Praxis, as Freire defines it, is the integration of reflection and action by people in order to transform the world (1973, p.66). However, it is just this integration of reflection and action which so often does not occur in the educational process. As Kindervatter points out in her 1979 study of education as an empowering process, in the two cases studied it was this phase of the cycle which did not occur. She points out that action as a result of reflection with critical consciousness can lead to action which "confronts the causes, rather than the symptoms, of a problem" (p. 232).

This ability to reflect critically, with the self-conscious knowledge that choice in action is possible, is what is lacking in educational programs and in societies like ours where action without self-consciousness continues to promote oppression here and abroad.

There is, however, a second aspect to the problem. Although experience is perceived as important to learning even by those who do not use purely experiential methods, the interactive or dialectical nature of experience requires greater elaboration than it has received in educational circles to date. The concept is straightforward: by acting upon something we change it and we, in turn, are changed by that action. Evidence that such change can be physiological as well as psychological is presented in subsequent sections of this study. It is this change occurring as we experience, as we act, which provides the substance for reflection enabling us to learn.
Experience cannot have meaning, says Dewey, without some element of thought, and "(t)hought or reflection...is the discernment of the relation between what we try to do and what happens in consequence" (1916, 1944, p.144-5). However, this power of reflection receives little direct attention in teaching methods. The ability to direct reflection through self-conscious attention is not treated as teachable or trainable except in a very few circumstances which seldom carry over into mainstream education. Accompanying this lack of focus on reflective skills is an unfortunate development of long standing in the history of the science of knowing: a mistrust of, and therefore lack in understanding of, subjective knowledge and its companion skill, introspection.

The psychology of learning and teaching has, until very recently, persistently ignored the information available to us about how the brain is involved in both learning and teaching. Although all too many of the details of brain physiology are frustratingly speculative, I believe that enough basic knowledge is available to be seriously considered supportive to the development of critical consciousness as a teaching methodology. Hypotheses which neurobiologists are willing to state or speculate upon give reason to explore self-conscious choice as a key to the development of the brain's critical capacity.

The purpose of this study is to explore consciousness as a process which transforms experience into action, to explore learning as it relates to the brain's capacity for reflection and choice,
to consider intuition as a special aspect of learning, and to describe introspective skills which can be used (and tested further?) in the development of critical consciousness.

Procedure - An Exercise in Subjective Knowledge

For this study the consideration of consciousness will be wholistic in the sense that many fields of knowledge are considered relevant to the discussion. The study does not pretend, however, to consider every field of knowledge and does focus primarily on the psychology and neurophysiology of learning. The focus on the latter may be viewed as reductionist. Like others who enter the fray to begin to define consciousness, I cannot subscribe completely to either the wholistic or the reductionist view, but prefer to take an integrative approach from as many fields as possible.

Although I seek to make a case in Chapter II for a new paradigm to help us understand consciousness it will become evident to the reader that my own conceptual framework is heavily influenced by the historical materialist approach (in particular, the dialectical aspect of this approach) to the study of change and human development. I take this approach for a specific reason. I agree with William Connolly (1974), a social scientist, and Robert Miller (1981), a neurobiologist, who both believe that scholars in their respective fields ought to become more self-conscious about the theoretical paradigms within which they work. For Connolly an important aspect of developing such a critical self-conscious capacity is the accompanying increase in deliberate choice:
...Aware now more fully of my habits of classification and interpretation, I open myself to new possibilities. I convert, to some degree, unconsciously acquired predispositions that have conditioned my thought into more fully conscious constructs. What was a force acting upon me becomes...one among alternative orientations that I can choose to develop, or to alter, or to reject. And in making conscious a tacit dimension of thought, I increase the extent to which my future choices can be influenced by rational argument (1974, p.62). (Emphasis in original.)

As an American living in a capitalist society, I was brought up in what Connolly calls the "consensus" perspective (also known varyingly as functionalist, idealist, capitalist). I only became aware of this tacit world view and how strongly it influenced my opinions, values, attitudes and choices after exposure to the materialist view. I have found, as Connolly says, that exposing my values to alternative theoretical structures has "made conscious a tacit dimension of thought." By using an opposite paradigm to analyze my own I believe I have become more open to the integration of the variety of perspectives which are synthesized in this paper and which may provide groundwork for new directions in education.

This study began, I suppose, when I first became aware as an adolescent struggling with gymnastics that I could perform activities heretofore impossible for me, such as climbing ropes and swinging upsidedown from the rings, by thinking about the parts of my body and in what order they needed to operate for each activity. I did not understand whether applying this method of thinking was how the athletic kids managed to do everything perfectly. I knew simply that it was the only way for me to do gym-
nastics. Since then, the possibility of thinking about how I think and act has entered into my life in various forms: in trying to discover why mathematics was always difficult; in attempting to control my temper; in striving to overcome severe anxiety and depression; in crosscultural training, and as a teacher.

In all of these endeavors the role of subjective knowledge was evident yet unsung and often inexplicable. While a student and later while teaching in an experiential graduate program at the School for International Training in Brattleboro, Vermont, experiences in crosscultural training began to indicate possible explanations for the validity of knowing subjectively. These experiences and subsequent work training educators in evaluation of nonformal education programs and in crosscultural communication at the Center for International Education, University of Massachusetts, have provided the structure for this study.

Procedures for implementing this study include a synthesis of personal experiences in adult education; an investigation of literature in the fields of education, creativity, philosophy, political economy, psychology, neuropsychology, neurobiology, and theoretical physics; and the formulation of an explanation and method for acquiring subjective knowledge based on this synthesis and investigation.

Scope - A Framework for Consciousness

In this paper, consciousness is viewed as a process through which experience is transformed into information and information is
transformed into action. Viewed at another level, consciousness is a process which transforms the cosmic reality of subatomic particles, waves and fields into the daily reality of objects and experience. At still another level, we might say that consciousness is what occurs when the particular combination of matter and energy which constitutes our brain acts upon sensory input (in the form of energy) and transforms it into a symbolic system with which we can communicate to others what we have experienced. More simply, consciousness can be viewed as a composite of neurophysical properties and societal reflections whose interaction enables us to grow and change.

In an attempt to simplify what can obviously become a multitude of definitions, the following five aspects of consciousness are presented as a guide for the issues to be dealt with in this paper.

Consciousness, like other living forms, is affected by its composition. That is, although we may not choose to define consciousness as simply matter in motion, we can say that consciousness is affected by the constant fluctuations of energy which characterize other phenomena of nature. First of all, therefore in constructing a framework for consciousness, we will consider explanations from modern physics which include relativity, uncertainty, complementarity and dissipative structures as guidelines for the nature of change which can characterize consciousness.

Second, consciousness also is influenced in dialectical fashion by our interaction with our environment. The illusory function of
consciousness translates the energy forms received by our senses into information which helps us to survive in our environment. This illusory function, however, sometimes acts to the detriment of the critical function of consciousness which may be seen as presently being subordinated to the illusory function.

Third, although consciousness may not be limited to the products of brain anatomy and physiology, this study assumes that the information gleaned from studying how brains work is relevant and useful in identifying methods for developing critical consciousness. Hence the study will describe physiological and anatomical mechanisms which have been shown to be or are believed to be related to the critical function of consciousness.

Fourth, it is assumed that consciousness is involved in learning and that learning is enhanced through intuition, a capacity of the brain for which a physiological basis has been proposed. The study will describe this capacity for intuition and how it can be used to enhance the critical function of consciousness.

Fifth and finally, self-conscious choice is a capacity which can be developed through certain skill areas relating to introspection which curriculum can be designed to include. These skill areas will be identified and described in detail.

Definition of Terms
Choice
Consciousness
Selection among alternatives.
The totality of experience, and a transformation process.
<table>
<thead>
<tr>
<th>Critical Consciousness</th>
<th>Implies testing one's own perceptions and explanations, rejecting passivity, accepting responsibility, becoming the subject or creator of history, rather than the object (Freire, 1976); transformation and reflection through self-consciousness.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience</td>
<td>Apprehending nature through the senses; acting upon nature and undergoing the consequences of that action.</td>
</tr>
<tr>
<td>Illusory Consciousness</td>
<td>Transformation without self-consciousness.</td>
</tr>
<tr>
<td>Intuition</td>
<td>Access to the totality of consciousness.</td>
</tr>
<tr>
<td>Learning</td>
<td>Changing through experience; reflection on that experience.</td>
</tr>
<tr>
<td>Self-Consciousness</td>
<td>Knowing through reflection or introspection; internal awareness of physiological signs and thought patterns. (Subjective knowing)</td>
</tr>
<tr>
<td>Self-Conscious Choice</td>
<td>Implies the understanding of consciousness as a changing force, capable of self-direction; applying this understanding in thought and action by attending to one's innate capacity for choice.</td>
</tr>
</tbody>
</table>

**Summary**

A brief background stating the need for the development of critical consciousness in an industrialized society such as the United States began this chapter. It concluded by stating the need for education to emphasize the development of self-conscious choice to help cut through the illusions which bind our society and
promote oppression here and abroad. The problem to be dealt with is twofold: a lack of understanding of interactive nature of experience and learning; and the lack of emphasis on reflective capacity as a skill for developing critical consciousness.

The description of procedure emphasized an endeavor to be self-conscious about one's theoretical framework and to employ an opposite paradigm to increase one's critical capacity. In this case the materialist framework was purposefully sought to counter a tacit idealistic framework. However, the study proposes to suggest a paradigm which is integrative of a number of frameworks. Finally, five aspects of consciousness were mentioned which will provide an overall structure for the following presentation. First, consciousness is a constantly changing phenomenon, like other aspects of nature. Second, consciousness is interactive with and influenced by the environment giving it both an illusory and a critical function. Third, brain physiology constitutes a basis for understanding the critical function of consciousness. Fourth, intuition is a reflective capacity of consciousness which enhances our capacity for critical consciousness. Finally, self-conscious choice can be developed through practicing skills in introspection.

In the next chapter, we will step back to take a look at the historical development of certain ideas and practices which currently affect our notion of consciousness and how we acquire knowledge. This will include looking at how use of the scientific method evolved. The chapter is primarily concerned with understanding
"ways of knowing" and how these have come to be divided into apparently opposing ways, such as inductive and deductive thinking. The nature of experience and how we can learn from experience is considered in more depth especially as it relates to developing skills for critical consciousness. Finally, ideas are presented regarding the need for a new paradigm within which to pursue the development of consciousness.
NOTES

1. "...all the molecules of the body are continuously being broken down and reformed, and the brain is no exception to this rule - indeed, the average life of a small molecule in the brain may be a matter of minutes only, while 90 percent of the proteins of the brain are broken down and replaced by new, presumably identical molecules within a period of no more than fourteen days or so."


2. In Schooling in Capitalist America (NY: Basic Books, 1976) p. 147, Sam Bowles and Herb Gintis provide a detailed analysis of the role of education in supplying the specific forms of labor required by our system. "The perpetuation of the class structure requires that the hierarchical division of labor be reproduced in the consciousness of its participants. The educational system is one of several reproduction mechanisms through which dominant elites seek to achieve this objective."


4. For definitions of "holistic" and "reductionist" please see Steven Rose, The Conscious Brain, p. 27.
CHAPTER II

A NEW PARADIGM

And the change in (us) begins with the change in (our) understanding of the 'meaning of consciousness' and after that with (our) gradual acquiring command over it. (16)

P.D. Ouspensky

Introduction

Attempting to say something meaningful and useful about consciousness is akin, at times, to making a long distance telephone call these days. There are many connections, but no certainties. Yet the expanding literature indicates heightened interest from a wide range of disciplines. And in some cases, albeit a few, we find some scientist or philosopher willing to suggest a hypothesis for testing. I am a teacher, and I hope that this discussion of consciousness will in fact suggest hypotheses to be tested by other teachers.

Some others have recently written about the brain and education (Hart, 1983). This paper is also about the brain and education. But it is also about consciousness because it is time for education as a science to join its discoveries about human consciousness with, for example, those emerging from neuroscience and physics. The brain is knowable and consciousness 'commandable' through self-conscious discipline for which skills can be taught.
Becoming self-conscious has a number of facets. One of them concerns being self-conscious (i.e., self-aware rather than nervous) about one's paradigm or world view when engaged in research and writing (Connolly, 1974). The first section of this chapter is an attempt at describing certain critical features of a paradigm which have permeated all of my thinking and education, both formal and informal, up to the present. Although I believe this same paradigm has permeated the consciousness of the West in general, the critical features, or "oppositions" highlighted here have special significance for my particular view of consciousness. Their presentation is not meant to imply a definition of Western thought.

In addition, if I want to practice self-consciousness regarding paradigms it is important to state that my interest in brain physiology as a basis for designing educational methods stems from an intuitive regard for certain explanations which are currently called materialist. Perhaps as the paper progresses, however, an integrative approach will become evident.

A Short History of Ideas

This history, as mentioned, is highly selective but may present a useful backdrop against which to examine current ideas about consciousness. It is assumed here that the history of ideas is a representation of a type of collective consciousness of Western society and the United States in particular. To analyze this collective consciousness we can begin by looking at what peoples' explanations were for why and how things happened in the world. With-
in the explanations which arise are contained "oppositional pairs", for example, materialism and idealism, inductive and deductive thinking. And from within these pairs a type of synthesis is derived which may point toward a new paradigm.

Materialism and Idealism

As explanations of why and how things happen in the world and in the universe, materialism and idealism are usually posed as opposites and have been posed that way since at least the 6th century (500 B.C.). This paper will not attempt to trace these two concepts in detail from early Greece to the present. What concerns us is how they shape the world view of their respective proponents today as well as then, and how this influence affects our own practice in education and other fields.

Plato and Aristotle, two familiar bulwarks of one of the main philosophical traditions of Europe and North America, are given credit for the explication of early forms of the idealist philosophy. While Plato attributed the existence of ideas to "divine origin" or God, Aristotle demurred from divinity to suggest a 'first mover . . . exempt from all change" (Cameron, 1973, p. 211). Two who may not be so familiar to us, Democritus and later Lucretius, set down major points of the materialist explanation. In about 50 B.C. in a work entitled De Rerum Natura (Of the Nature of Things) Lucretius wrote:

Certainly, the atoms did not post themselves purposefully in due order by an act of intelligence, nor did they stipulate what movements each should perform. But multitudinous
atoms, swept along in multitudinous courses through infinite time by mutual clashes and their own weight, have come together in every possible way and realized everything that could be formed by their combinations (Cameron, 1973, p. 214).

A fairly continuous debate between materialist and idealist philosophies has persisted through the centuries. In both explanations there is a recognition of something referred to as "matter" and something referred to as "spirit." As we have noted with Plato, (according to Cameron) we consist of "...mind and body, mind being analogous to God, (e.g. spirit) the body to matter" (p. 209). Lucretius, the Roman materialist who lived some 250 years after Plato, sees it somewhat differently:

There is no dichotomy between body and mind. Mind interacts with the body through an intermediary, a 'vital spirit' ...which gives life and movement to the limbs and veins and bones. This 'vital spirit,' like the body, consists of atoms (Cameron quoting De Rerum Natura, p. 215).

It is Plato's interpretation, a world which consists of a division between matter and spirit, which has received the stronger emphasis in Western consciousness. Although he modified this position somewhat, Aristotle thought that "...Nature has an 'end' or 'goal' always in view and shapes things toward it" (Cameron, 1973, p. 212). Whether or not Aristotle meant for this "purposeful Nature" to represent a divine being or God, subsequent philosophical and religious tradition interpreted it that way.

So the idealist view began to take precedence in the consciousness, the philosophy and the practice of Europe. But why did Aristotle's views have more staying power than Lucretius who
came after him? Capra suggests that it was a "lack of interest in the material world" which left the "Aristotelian model of the universe...unchallenged for so long" (until the Renaissance) as well as "the strong hold of the Christian church which supported Aristotle's doctrines throughout the Middle Ages" (Capra, 1975, p. 8).

But then, we may ask, what caused this lack of interest? In the preceding discussion of consciousness it was proposed that consciousness is, in part, a reflection of society. Thus it is also important to consider Cameron's suggestion that "...each society has its own needs in regard to ideas (and) knowledge" (p. 215). The patterns of society in Greece and Rome at the time and up until the Renaissance included commercial societies based largely on slave labor and later, throughout Europe, a strong feudal system. In Cameron's view, "A feudal society had no more use for the ideas of Lucretius than it had for the experimental method..." (p. 215). He implies that the dominance of the Christian church both as a landholder and spiritual guide would naturally have found materialist ideas heretical and therefore such ideas were not perpetuated among the educated. And if the uneducated happened to find themselves thinking about such things, social forces were strong enough to squelch any significant development of those ideas. Whether one fully supports this interpretation or not, Europe during the Middle Ages did not yield any significant addition to the materialist explanation. It is important to remember, in
any case, that this division between matter and spirit is another "opposition" which concerns us in understanding consciousness. **Emergence of the Scientific Method**

One view of finding out how people tried to explain why things happen is to consider their answer to the question "Where does knowledge come from?" (Politzer, 1976). The answer for Europe for a couple of thousand years was "Knowledge comes from the mind which is also spirit, God." As we trace the influence of this choice on the development of human consciousness we next are concerned with the question "How do things happen?"

With this question we move from the more philosophical "why?" to the "scientific" (as it came to be known) "how?" Philosophical inquiry is based on "logical reasoning rather than empirical methods." Science is defined as "the observation, identification, description, experimental investigation, and theoretical explanation of natural phenomena." We should also note for later discussion however, that science is also defined as "knowledge; especially, knowledge gained through experience" (American Heritage Dictionary).

Lincoln Barnett, in a summary of scientific developments, also suggests that it was Aristotle's tendency to focus on "why" and his belief that one "could arrive at an understanding of ultimate reality by reasoning" (1948 p. 15), that influenced the direction of science toward the spiritual for so many centuries. He concurs with Cameron and Capra that the Renaissance, a period roughly lasting from 1300 to 1500, heralded a new turn in science. Euro-
pean commerce expanded significantly across continents and oceans. New technologies were required to meet this economic expansion and simultaneously came a burst of new or revived information about how things work. The technology required by this great commercial expansion and simultaneous inquiry regarding the motion of planets, water pressure, magnetism, mining and metallurgy and an array of other areas (Cameron, 1973, pp. 325-6), led Galileo, Newton and others to ask how things happen, but in a special way which had not been generally used since early Greek and Egyptian thinkers had used it -- through the use of controlled experiments or what would come to be known as the scientific method.

Another area of scientific endeavor was influenced greatly by the Renaissance activity. Mathematics began to be used beyond the realm of astronomy becoming a major component in the scientific method. Mathematics - "the study of number, form, arrangement, and...relationships, using...symbols" - played a very important role in the development of scientific method because of its unique function of translating observable phenomena into symbols which can be manipulated to create logical "proofs." These proofs can then be demonstrated to conform to established "laws" of science or can be used to formulate new laws or patterns to describe how things work. This capability of consciousness to create and manipulate symbols took on significance as a way of knowing, of ascertaining, the certainty of the how of happenings.
Scientific method has three basic steps: first, gathering experimental evidence; second, correlating the experimental evidence with mathematical symbols and then constructing a mathematical model or theory and using this model to predict results of further experiments which help to check the accuracy of the model (this part sometimes referred to as hypothetico-deductive method and dependent upon the mathematical function described above); and third, formulating a model in "ordinary language" to explain what the mathematical scheme has demonstrated (Capra, 1975, pp. 17-18).

On the one hand the universal acceptance in Europe, hence in our U.S. cultural heritage, of this basic form for scientific investigation, helped establish a fairly integrated and efficient system for the production of scientific knowledge. It provided a method for exploring how things worked and in addition a system for establishing the fact, proof, or "truth" of an event. This universal acceptance among both "natural" and "social" scientists led also to the development of a series of convictions about how fact or truth is established based on certain "oppositions" which, as we shall see, may now be a hindrance to a clearer understanding and use of human consciousness.

**Experience Is Not Enough**

One of the measures of the complexity of consciousness is exhibited in the number of words we have for describing it. We have general categories such as thinking, knowing, reflecting, dreaming; then more specific descriptors such as logic, reason, intuition; and
still finer distinctions such as inductive, deductive, objective and subjective thinking. As people have attempted to clarify how we know how things happen (i.e., the "proof" or certainty of how things happen) various of these descriptions of what takes place in consciousness have taken on almost mutually exclusive meanings, leading us to sedentary rather than creative views of the mind's potential.

As noted above, the move from more philosophical explanations to more scientific explanations involved a shift from "logical reasoning" to "empirical methods." That is, thinking something through in the head was not as acceptable a proof of an explanation as was an empirical demonstration - an experiment in which results could be observed, noted down, communicated to others and compared with previous and subsequent results. An hiatus between these two forms of acquiring knowledge has developed over the centuries in an indistinct yet very influential way. Acquiring knowledge through reasoning or thinking alone, that is, through introspection, through theorizing, became identified as a subjective method and therefore unverifiable by scientific means... unless the theory were so constructed as to be able to be tested by empirical method. Acquiring knowledge empirically, i.e., from "observation or experiment; guided by practical experience and not by theory" became identified as an objective method, verifiable through others' experience as well as one's own. In addition to this dichotomy between reason and practical experience there also
emerged some often confusing distinctions between induction and deduction as ways to know; and between objectivity and subjectivity as characteristics of knowing, and about the nature of experience in general.

**Deductive and Inductive Thinking**

Although very little has been revealed to us about the brain's processes until recent years, there are some compelling aspects about how we think that philosophers and scientists have agreed on using introspection as proof rather than observable phenomena. The Greeks of Aristotle's time and possibly others before them differentiated between inductive and deductive thinking. Aristotle was a proponent of the deductive process - assuming a general principle and deriving particular points from it (Cameron, 1973, p. 211, Barnett, 1948, p. 15). Socrates on the other hand is famous for his inductive arguments, deriving general principles from the investigation of particular points (Cameron, p. 210).

Since that time, philosophers and scientists have taken very definite positions on which type of thinking leads to the acquisition of knowledge. With Rennaissance discoveries came Francis Bacon who postulated, in the late 1500's, that

The induction which is to be available for the discovery and demonstration of sciences and arts must analyze nature by proper rejections and exclusions...Matter, rather than forms...should be the object of our attention, its configuration and changes of configuration, and simple action, and laws of action or motion; for forms are figments of the human mind unless you will call those laws of action forms (Cameron, p. 336).
Bacon was convinced that useful explanations were to be derived from observing matter in motion and its laws, a fairly straightforward materialist position rather than "forms" here taken to mean ideas. He suggests observing the myriad actions and changes of matter in order to formulate laws -- an inductive approach.

Rene Descartes, born 30 years after Bacon, contributed substantially to the development of scientific knowledge, primarily through his work in mathematics (geometry) and philosophy. He was a firm protagonist of the deductive approach, emphasizing that he must exercise doubt regarding anything of which he "had been convinced of only by example and custom" (Miller, 1981, p. 190, quoting from Discours de la Methode, 1637). David Hume, a philosopher of the early to mid 18th century, took a stronger position regarding the primacy of "reason" (deductive thinking) over "custom" (inductive thinking) (Miller, 1981, p. 8).

The struggle to establish the primacy of one or the other of these types of thinking, was, after all, the struggle of philosophers to ascertain exactly how the mind knows or how it grasps reality, to paraphrase Cameron (p. 339). Accompanying this debate about the process of consciousness was another debate about the structure of consciousness. That is, from Plato to Locke to Kant there was a debate over the contents of the mind at birth. Plato believed that the mind or consciousness was an extension of God and contained ideas at birth. Locke presented consciousness as a 'blank tablet' at birth with "capacities and instincts, but no ideas" (Cameron, p. 339).
However, in the work of Immanuel Kant, towards the end of the 18th century, especially his *Critique of Pure Reason* a substantial change can be noted in the view of the oppositional nature of these two "types" of thinking. Kant rejected the blank tablet idea and added to his picture of consciousness elements of time, space and causality which have special significance for the ensuing discussion of our capacity for critical consciousness. Cameron describes Kant as regarding the mind

...as a set entity with its own inherent laws...In these "laws" ("forms of intuition," "categories") lies the essence of his answer to Hume and to Locke. The mind is not a blank tablet at birth but possesses frameworks into which it places the knowledge which it acquires. Among these (categories) are time, space, and causality. Time and space have no objective existence but are simply ways in which the mind digests what the senses reveal to it. There is causality, but it is an internal, not an external phenomenon (p. 342).

In addition to the idea that the mechanism for understanding time and space were inherent in the mind, Kant delved deeply into what Robert Miller, a neuroscientist, has recently referred to as "varieties of inference." Kant identified what he called "synthetic statements" which were the result of inclusive thinking or inference, and "analytic statements which resulted from deductive inference (Miller, 1981, p. 187-8). Kant's detailed analysis of the examples and progression of these conscious processes have, through Miller's analysis, yielded two points significant for this study. The first is that Kant indicates that both inductive and deductive inference can have similar origins in process, that is, they can both be of the "a priori" or non-empirical type requiring no new information
from the outside but rather based on that "stored in the past," (i.e., subjective knowledge) (Miller, p. 188). Second, Kant's treatment of these processes requires attention to the prospect that conscious ability to recognize spatial and temporal patterns may be a function peculiar to inclusive or inductive thinking (Miller, p. 187).

Kant's perceptions help to bring some order to the confusion about inductive and deductive thinking. The issue need not be which is more reliable than the other, but what similarities and differences they have as processes of consciousness and, how they can be used. A similarity, as stated above, is that both can make use of knowledge already in the head (instead of deduction always depending on newly observed information). A difference is that deductive thinking tends to be analytical, picking out details, while inductive thinking synthesizes details.

These distinctions bring to mind those which have lately been identified as "left" and "right" brain functions, the deductive corresponding to left brain activities and inductive to right brain activities. (We will refer to the right/left model in more detail later.) Mainly, however, the deductive/inductive distinction can be viewed as, perhaps, an unconscious recognition of the illusory and critical functions (respectively) of consciousness. Deducing from an assumed principle corresponds to the way in which our illusory consciousness allows us to operate from day to day on basic (usually unconscious) assumptions about our reality. Inducing or gathering
together many particulars (from the whole store of our knowledge) corresponds to the wholistic critical function which can permit new perspectives. A further connection between these two types of thinking and the ideas of space and time, and causality, will be discussed in Chapter III.

In the long run, as Robert Miller suggests, "...deduction and induction should interact in a subtle and delicate balance" (1981, p. 191). In order to achieve such a balance we need to be aware, self-conscious, of how we personally make use of these functions.

Subjectivity and Objectivity

The foregoing discussion on the validity of two apparently contrasting ways of acquiring knowledge leads us almost inevitably to consider another distinction between a pair of "opposing" aspects of knowing: the subjective aspect and the objective aspect. Origins for this historical opposition can be found in as well in the prolific musings of Rene Descartes. The body, for Descartes, was "...a machine driven by a hydraulic system of vital liquids coursing down the nerves..." and this system was driven by the soul. The soul resided in a tiny organ (the pineal gland) and was separate from both the brain and the nervous system (Rose, 1976, p. 39). This dualism, of mind (soul) and brain survives in many current explanations of consciousness.

Capra believes that Descartes' "fundamental division between the I and the world" (1975, p. 45), solidified for the next few centuries the ideas that cause and effect could be determined for "all
the forces acting in nature" in LaPlace' words. Therefore, according to Descartes, the material universe is predictable and totally separate from the human observer. Hence "the world could be described objectively...and such an objective description of nature became the ideal of all science" (Capra, p. 45).

In fact, the use of these concepts - subjectivity and objectivity - are so common in our everyday communication it is very difficult to set them apart and analyze them. To "take an objective viewpoint" or to "speak subjectively" about a topic are phrases we use and postures we try to assume regularly in our daily interchanges with people. But what does it mean to be subjective or objective? Subjective usually connotes something personal or individual. It also is defined as "existing only in the mind" "unaffected by the external world" and "illusory." These seem familiar synonyms. In psychology the term is somewhat more specific. Generally something subjective is to psychologists (and others) something that exists only "within the experiencer's mind and incapable of external verification." However, it is also important to note the first, i.e., most acceptable, definition: "Pertaining to the real nature of something; essential."

Objective has a similar range of opposite meanings: "of or having to do with a material object as distinguished from a mental concept, idea, or belief; having actual existence or reality; uninfluenced by emotion, surmise, or personal prejudice; based on observable phenomena, presented factually."
These dictionary definitions help us to see how objectivity came to be associated with the experimental method as the scientific way to view things while subjectivity has come to be understood, as the psychologist's definition above, as something not externally verifiable, i.e., not scientific or not as valid a way of knowing as the experimental method.

The distinction between objective and subjective ways of knowing parallels that between deductive and inductive inference. \(^2\) Objective knowledge is factual, demonstrable to others through a generally accepted mode (scientific method) or immediate sensory verification ("That fire engine over there is red."). Participants in the exchange of objective knowledge share in the experience and can agree within accepted parameters on what they observe or sense. Subjective knowledge is opinion, demonstrable through verbal or visual description and upon which participants may not agree about what is observed or sensed ("I think it's going to rain."). Occasionally an experience occurs when participants do not agree on what ought to be an objective bit of information, for example "I love that green car!" "Which one? Oh, that's a blue car, I like it too."

This last example reminds us that knowledge is obtainable through experience and that experience is mediated (made possible) by the senses. A basic unity underlying both objective and
subjective knowledge resides in this physiological fact. In discussing this "duality" which pervades our investigation of knowing (i.e., experience vs. observation, induction vs. deduction, objective information vs. subjective information) Robert Miller stresses that knowing something subjectively, through introspection, is a necessary part of making an objective assessment. "All objective observations depend on the existence of an observing subject and (his/her) capacity to form subjective impressions" (1980, p. 11). People can agree on the objective certainty of an experience only after they have made their personal and subjective assessment. And this assessment is based on experience as a process of consciousness.

The Call for Unity and the Recognition of Intuition

If we can accept that observing is an experience, that inductive and deductive thinking are complementary processes, that subjectivity supports objectivity, the differentiation between those "oppositions" becomes almost semantical. We have accepted that one type of thinking leads to certainty and the other to speculation. Yet the definition of certainty and the rules by which certainty is obtained have also been agreed upon by individuals, in their personal, subjective capacity. This individual capacity for accepting and defining certainty underlies a very significant and very poorly understood capacity of consciousness which, in turn, links these oppositional modes at a subconscious level. This unifying capacity of consciousness is otherwise called intuition.
A great deal has been written in the past two decades about the respective functions of right and left sides of the brain (Ornstein, 1968). Very roughly it has become popular to link analytical capacities with the left hemisphere and intuitive capacities with the right hemisphere. Recent research has shown the two hemispheres to be a great deal more interactive that was originally thought, however it is also generally agreed that our intuitive "side" is, for most people, not as well developed as the analytical (Hart, 1983). John Eccles, a prominent English neurobiologist whose research on cellular functions in the brain is basic text around the world, and others, refer regularly in their work to the left brain hemisphere as the "dominant" and the right hemisphere as the "minor" (1977; Luria, 1973).

The interactive nature of the two hemispheres has been emphasized in research which suggests a "lexical organization" in the right hemisphere which supplements the left hemisphere's language mechanisms (Zaidel, 1977). In addition, Eran Zaidel's further research at the California Institute of Technology showed that when patients who had use of only one hemisphere were asked to perform the same task, the basic difference between hemispheres was not one of "final competence but one of performance style" (1977, p. 283). Therefore it is likely that the left-right distinction is useful more for description of the complex arrangement of consciousness than for actual physiological identification.
Another way of viewing the apparent separation of brain function is through the "triune" brain theory proposed by Paul MacLean (1973). This theory proposes that the human brain consists of three totally integrated areas but with each area having a different evolutionary role. The reptilian brain, the earliest to form in mammals and a holdover from our reptilian ancestors, is generally responsible for the basic regulation of bodily functions and the condition of readiness or wakefulness at any one time. The limbic system, present in all mammals, appears to be what MacLean refers to as nature's attempt at a "respectable cortex" or "thinking cap" for the reptilian brain "...giving the mammal a better picture for adapting to its internal and external environment" (1973, p. 12). The limbic system, as we shall see later, plays an important role in regulating emotions, especially in terms of self-preservation and preservation of the species (MacLean, p. 12).

The third portion of this triune picture is the "new mammalian brain" or the neocortex which is the large uppermost portion of the brain enfold ing the other two (please see Figure 5). This portion of the brain is responsible for the processing and storage of information and the ability to both remember and plan. It is this area of the brain which is most fully developed in humans and to which most of the discussion of physiology in this paper will relate. In his description of these outer hemispheres, Luria makes a distinction between the posterior portion which analyzes, codes and stores information and the frontal or anterior portion which forms
Figure 5: Brain
(Adapted from Bob Conrad)
"intentions and programs," (please see Figure 4a) (Luria, 1972, p. 25).

Our intuitive capacity is linked most directly with this third portion of the "triune" brain. The abilities to plan, to take intentional action, to formulate, follow, and reformulate programs (such as driving to work by a certain route) all rely on the billions of nerve cells of various species which make up this part of the brain. In this study, intuition is viewed in part as a capacity of consciousness which assists in a special kind of retrieval of information from this vast area where the brain stores its knowledge.

A direct link is suggested between the intuitive capacity of the brain and our capacity for obtaining certainty through inductive and subjective ways of knowing. However this does not mean to suggest, in the oppositional style described above, that intuition is separate from objective and deductive ways of knowing. This is a serious call for understanding consciousness in holistic fashion. Subjective and inductive modes will be emphasized because their "minor" position has seriously inhibited the development of intuitive capacity in individuals in our society (Hart, 1976, Bastick, 1982).

We have stated that we learn from experience but that somehow, as society has developed, "experience" was not enough to convince us, experience as interpreted by the individual did not hold enough certainty to be considered a valid base for knowledge on its own. Experience is the base from which we know all that we
know. Experience is the base from which we become all that we become. In this next section we will consider the interactive, dialectical nature of experience and its significance for the development of critical consciousness.

The Nature of Experience

Separating Reason from Experience

The foregoing pages have outlined the progression of Western thinkers toward the development and use of a method of acquiring knowledge that is considered to be essentially deductive in approach, that requires experimentation based on agreed format, and that assumes this experimental process to result in the collection of data that is verified and acceptable because it is replicable by numerous other people through similar experiments. This method, as we have said, is thus, firmly grounded in a concept of "objectivity" implying that the experimenter or scientist, the observer, is and remains outside the activity of the experiment, having no effect but to record results.

August Comte, living in the first half of the 19th century, made substantial contribution to systematizing this method, not only for the natural sciences but for the social sciences as well. His belief was that all knowledge had to be based on the "positive" data of experience in order to be considered fact. This Positivist approach is dominant in scientific inquiry today. For those of us who celebrate experience as the key to knowledge, such an approach should hold no difficulty. There is a difficulty, however, and it arises as we explore what is meant by experience.
The scientific method outlined above assumes that the experience from which knowledge or fact is being obtained is what goes on before the eyes of the observer (the scientist). The scientist's observation of this experience which is external to him or her is then recorded symbolically (in mathematics or words) and becomes after significant replication, objective fact. The experience of the instruments, animals, people, subatomic particles and whatever else might be involved in a variety of types of experiments are said to be unaffected by the observer, thus the recorded results have a validity of their own, external to the observer of the experiment.

One outcome of this view of acquiring valid knowledge about something was that it became impossible for introspection to be a method for learning and knowing, at least in the universally accepted sense of the 'objective' method described above. Thinking about one's own inner processes became a subjective enterprise, not verifiable by others and therefore not useful in general to society. Any 'subjective' data gathered through thinking something through in the head was not really measurable, not really collectible data, and therefore, could not be accepted as proof for a statement resulting from the introspection or thinking. Michael Polanyi has termed this the "separation of reason from experience" (1958, p. 9). It is a major premise of this paper that thinking about how we acquire knowledge is an integral part of any educational curriculum. Each learner, as he or she becomes more self-
conscious about how he or she learns, develops the capacity to learn all the more. Hence, the use of 'subjective' knowledge, the exercise of introspection as a learning skill, becomes of primary importance in education.

In order for this to happen, however, definitions of what is valid experience, what is valid information, will have to undergo major adjustments in our Western scientific paradigm. My own experience of what goes on inside my mind has, in some way, to be accepted as fact rather than illusion. If we recall the definition of subjective stated above "pertaining to the real nature of things; essential" - it is this understanding which needs to become popular.

**Experience Changes Us**

To begin, it is helpful to consider Karl Marx' concept of human beings as being "sensuous" in nature. A very important part of our humanness he says, is contained in our "essential powers" (Tucker, 1972, p.75). These powers or capacities (Ollman, 1971, p. 74), he divides into two types: natural and species. Our natural powers are those we share with other animals in an obvious way: laboring, eating and drinking, and sexual relations (Ollman, p. 83). Our species powers are those which may make us somehow different from other animals - "seeing, hearing, smelling, tasting, feeling, thinking, being aware...wanting, acting, loving..." (Tucker, p. 73). These species powers Marx often refers to as *senses*, hence the primary importance of our *sensuous* nature.
So if we are to take this as a model to help us better use and understand consciousness, we can say that human beings have certain "natural" capacities which enable us to carry on life as all other living creatures do. However, we also are "species" beings or "sensuous" beings with special faculty or ability not only to see, hear, smell, taste, and feel, but also possessing what Marx sometimes referred to as "mental senses" enabling us to think, be aware, want, act, and love among others. Such designations are not out of the ordinary, of course. What is special about Marx' conception of human nature is the relationship he ascribes between our powers or senses and the world outside each of us. To describe this relationship Marx refers to us as objective beings or beings who are "...affirmed in the objective world not only in the act of thinking, but with all (our) senses" (Tucker, p.74).

Ollman helps us to understand this type of affirmation by explaining that for each power or sense that we have, Marx posits a corresponding need through which we become aware of that particular power or sense. This need, in turn, implies a need for an 'object' and that this object is "necessary for (the) realization" of the power or sense (Ollman p. 76). The power to eat, for example, corresponds to a need - hunger - for an object or objects - food - which exist outside the body (Ollman p. 88). If we use this same example with another power, or in this case, a sense, the power of sight corresponds to a need - to see - for recognizing
objects external to us. The sense of sight is realized through the need to see. The power of eating is realized through the need of hunger. These human faculties or abilities come to be through action. Our senses become refined as we use them, as we engage them in experience.

And once again, what is experience? "...the apprehension of an object...through the use of the senses..."⁴ Experiencing is taking the essence of something - it's light, shadow, sound, volume, substance - into ourselves and, through consciousness, transforming this object into thoughts, and possibly, communications with others. Now how do we "take the essence of something" in? Sometimes we do this by using the senses in straightforward form - looking, feeling, smelling, etc. At other times we take in the essence of something when we act upon it to change it in some way, as in felling a tree, making a cake, or putting paint on canvas. Experience also involves us interacting with other people; and it also involves us interacting with ourselves through thinking, through introspection.

Experience is apprehending. Marx uses the term appropriating -we in some way make what we appropriate a part of ourselves (Oilman, p. 89). This aspect of experience holds the key to the development of consciousness. When we experience something in any of the ways mentioned, the senses or powers which we use in doing so are affected, are changed in some way. No, our eyes do not change perhaps, but the parts and processes of our brain
which allow vision to occur do change as a result of each visual experience. This change has a psychological and a physiological nature both of which are knowable, the former through introspection and the latter through the objectivity of technology.

The Dialectic of Experience

We have said that we are changed when we act upon nature. Our conscious processes help to "appropriate" the objects of our action, thereby bringing about change in us, change of which we can become aware. This is the basis of learning.

There is, however, an inescapable paradox, or contradiction if you will, about our relationship to each other and the rest of nature. Nature changes as we act upon it by felling trees, plowing earth and building parking lots. But nature also changes as we observe it, as we act upon it with our senses. This idea is not new to those who study perception and attention and find evidence that we are very selective in what and how we take information in. But the idea that we actually change something by looking at it has been demonstrated most graphically by research in the field of quantum physics.

In 1927, Werner Heisenberg was attempting to measure both the position and velocity of an electron. According to Newtonian theory measuring speed and position of a moving object is quite normal. Since an electron can only be made visible by using high frequency gamma rays, bombarding the electron in order to observe its position will effect both velocity and position of the electron.
It is possible to adjust the gamma rays so that one or the other property can be measured more exactly, but always to the detriment of measuring the other. If position becomes more exact, velocity changes all the more. This discovery is referred to as the Heisenberg Uncertainty Principle. But why should this affect anything beyond looking at electrons?

Because of Heisenberg's discovery, physicists have had to accept the fact that they, as scientists, as observers of the experiments they conduct, do, after all, have an effect on the experiment itself. The experience they are observing is part of their own experience. In this case, the light (gamma ray) that is projected onto the electron was necessary for Heisenberg's own visual process. Yet this element directly affected the object being observed (the electron). The observer's experience became a part of the electron's movement. Put another way, experimental observation of an object involved the observer in interaction with that object through the mechanism of sight which itself is a transformation of light energy. For a more detailed discussion of this aspect of quantum physics, please see "Shedding Light on The Subject" in the Appendix.

It is interesting to note, however, that this discovery did not cause experiments in physics to come to a grinding halt, searching for another method. The reality of the situation became that physicists could only measure the probability of the position of a particle, that is, its tendency toward one position and away from another (Zukav, 1979, p. 66).
The fact that observation of an event could affect that event has not prevented physicists from making remarkable and useful discoveries. In fact, it seems to be pushing them to frontiers which seem almost beyond comprehension, at least for Western minds. For the purpose of understanding consciousness, both this validation of the observer's experience and the acceptance of a subjective participation in an event which is considered a scientific method of obtaining knowledge, are highly significant.

**Self-Consciousness Through Reflection**

The validation of subjective experience which can be gained from attention to the phenomenon occurring in experiments in modern physics is central to the approach to learning taken in this paper. The neurobiological term for learning is "plasticity" which Timothy Teyler says "...implies a change in some aspect of the nervous system as a function of experience..." (1978, Preface page). Evidence that physiological changes occur in brain cells as a result of experience and the possibility for awareness of this change are basic to the study. This does not imply that we are able to or need to sense cellular change directly (although this may be possible) but that the mental or psychological aspects of this change are knowable to us.

John Dewey looks at the dialectical interaction of our relationship to nature as involving two elements: acting or "trying" and experiencing or "undergoing." "When we experience something we act upon it, we do something with it; then we suffer or undergo
the consequences. We do something to the thing and then it does something to us in return..." (1916, p. 139). However, as referred to in Chapter I, Dewey believes that experience does not have meaning, does not constitute learning, unless accompanied by reflection. "Reflection...is the discernment of the relation between what we try to do and what happens in consequence" (p. 1445).

This "discernment" of the dialectical happening of experience is the key to developing selfconsciousness. To be self-conscious is to exercise the capacity to reflect upon how we change nature and how we are changed by our action upon nature. And this capacity can be developed through awareness and skill training.

**A Paradigm for Consciousness**

To be self conscious is to know oneself in order to be more conscious, to "know with others" in a more meaningful way. The full development of each individual's potential is dependent upon interaction with others. Consciousness is a reflection of that interaction and of our interaction, our experience, with all of nature. To be selfconscious is to be aware of our experience and the dialectical changes involved in that experience. Awareness comes to us as energy through the senses and is mediated or transformed by the brain to provide us with knowledge. To understand consciousness better (to become more self-conscious) we must use these same senses and this same mediator: the only way we have of knowing more about consciousness is through consciousness itself. This is the self-mediated nature of humanity.
This chapter has outlined the historical development of a mode of gaining knowledge, the positivist mode, which through its lack of attention to subjective knowing makes the development of self-consciousness, hence the growth of consciousness an underdeveloped phenomenon. Scientific events of the current century, however, have brought about a recognition by some that stronger emphasis must be placed on the subjective aspect of knowing. The perspective is growing, beyond its usual proponents in the fields of psychoanalysis and creativity, that the "...internal, conscious, introspective experience is as valuable a source of science as is external physical measurement" (Kornhuber, 1977, p. 323). By neuroscientists (Kornhuber, 1977; Miller, 1981; Pribram, 1980), chemists (Prigogine, 1980), physicists (Capra, 1975), psychologists (Bruner, 1971; Davidson and Davidson, 1980) and educators (Freire, 1973; Hart, 1976) a concern of long-standing is being voiced ever more clearly.

If Thomas Kuhn's premise is to be believed, paradigms come and go but with considerable stress on systems of gaining and transferring knowledge. There is a change in paradigm approaching, according to authors cited above and some, for example, Brian Fay, believes that the shift can result in the development of a "critical social science" which recognizes, among other things, that "...a great deal of what people do to one another is not the result of conscious knowledge and choice..." and that is "built on the explicit recognition that social theory is connected with social prac-
tice..." and that practice can yield action in the interests of people's felt needs (Fay, 1975, p.94). Of particular relevance for this study are the developments in phenomenology and hermeneutics (Fay, p. 67) which have come forward to suggest readjustment in the positivist approach.

It really does seem that a genuine synthesis is in the making in which the foundations of the social sciences will be present in a mould radically different from the positivist model... (Fay, p.68).

In seeking a new paradigm we are concerned with both the link between theory and practice which Fay emphasizes and with the paradigm's approach to how knowledge is acquired. In a paradigm which supports the development of critical consciousness a guiding social theory would create expectations for people acting through self-conscious choice regarding their daily lives. In turn, such expectation would require a companion expectation for equal access to the means of acquiring knowledge. In this case "means" implies not only the social and political access but the personal physiological and mental "means" as well. Such a critical social science would seek systems providing nutrition, health care, and stimulating educational environments for all citizens.

"The Evolutionary Vision"

There is, among natural and social scientists alike, a growing belief in an "evolutionary vision" - a unifying paradigm which could explain physical, biological and "sociocultural" evolution (Janstch, 1980). The research concerns of people contributing to this vision have direct links with the view of consciousness presented in this
study. Foremost among these are the "self-organization paradigm" characterized by the Nobel prize winning work of Ilya Prigogine on dissipative structures, and the proposed holographic structure of memory being developed by Karl Pribram.

The framework for consciousness proposed at the end of Chapter I suggested that consciousness is a transformation process undergoing constant change itself and characterized by an interactive, dialectical connection with nature yielding, over time, both a critical and illusory function. In contrast to the closed system of earlier thermodynamic discovery, the dissipative structure is an "open system" which maintains its own structure by continually exchanging and transforming energy from its environment (Ferguson, 1980). The framework for consciousness also proposed that brain physiology constitutes a basis for understanding our capacity for self-consciousness choice. Karl Pribram's research has identified mechanisms which he believes to be responsible for self-conscious intentional capacity (Pribram, in Davidson, 1980, p. 51).

Other principles are contained in the evolutionary paradigm which correspond to the framework proposed here. In Jantsch's words certain aspects of the evolutionary vision will have "profound epistemological consequences for Western thinking." For example:

One of these aspects concerns a basic nondualistic attitude which is more or less new in Western culture. With it age-old dichotomies may be overcome, such as the dichotomies between nature and culture, the natural and the artificial, mind and matter, observer and observed, subjective and objective, collective and individual, and others (Jantsch, 1980, p. 4).
This paradigm will also be strongly influenced by the ideas of
the subjective nature of space and time derived from Einstein's
Special Theory of Relativity; by the uncertainty principle de-
scribed earlier; and by Niels Bohr's concept of complementarity
which takes into account the contradictory or "complementary"
particle/wave phenomena of light, for example, and states that
both views must and can be held together (Blackburn, 1973, p.
28). Consideration of these principles when investigating con-
sciousness has opened up vast reaches within the brain:

...there is speculation, and some evidence, that consciousness,
at the most fundamental levels, is a quantum process. The dark-
adapted eye, for example, can detect a single photon. If this is
so then it is conceivable that by expanding our awareness to in-
clude functions which normally lie beyond its parameters (the
way yogis control their body temperature and pulse rate) we can
become aware of (experience) these processes themselves (Zukav,
1979, p. 222).

The End of Prehistory

A critical social science would I believe find roots in the
Marxian tradition. Marx stated that it is not our consciousness
that determines our being but, on the contrary, our social being
which determines our consciousness (Marx, 1972, p. 4). In this
sense consciousness is a reflection of society's patterns. However,
we have also seen that consciousness and action (through exper-
ience) are interwoven through our capacity for self-consciousness,
for reflection.

This interwoven character, a dialectical nature, is seen both
in the concept of dissipative structures and the "unity of oppo-
predicted as the "relationship of subject and object" (Brennan-Gibson, 1973, p. 330), reach a new stage.

I would like to suggest that this oppositional character is part of a 'pattern' that will arise whenever human consciousness is active. This pattern is dialectical and therefore involves the interaction of opposite forces (arguments) which, when they interact, their interaction implies a progression of forces (ideas) along a particular path. A theory of dialectical movements in history is not new. What I propose to be new, however, is the linking of this dialectical process in the social sphere to a similar dialectical process in the human brain.

Perceiving the elements of our day-to-day lives in their totality requires a new kind of attention, a challenging paradigm which includes the workings of the brain and the workings of society. The inherent antagonisms between the possessing and the non-possessing classes can be studied to reveal explanations of the limit-situations we cannot see through. As well, the traditional antagonisms between student and teacher, between liberating and oppressing educational structures, can be analyzed and changed. The natural physiological tendency which allows our illusions to remain and dominate can be overcome through the growth and practice of self-conscious choice. We may then begin to leave this prehistory and enter the actual historical period of humankind where history is consciously controlled and created by people in community.
An Era for Critical Consciousness

Finally, this paradigm promotes the development of a people who are critically conscious, who are no longer "submerged in the historical process" as objects but become the subjects of history, its creators (Freire, 1973, p. 17-18). Through a pedagogy which recognizes the stages of consciousness he delineates and the empowering structure proposed by Kindervatter (1979) we can become praxis. Through reflection and action which truly transform reality we discover and become the source of knowledge and creation (Freire, 1970).

Summary of the Chapter

We have taken a look at some of the major explanations of how the world works, in particular those that have survived to influence our present day Western consciousness. We have also noted the rise of a particular method of acquiring knowledge, the scientific method, which has also superceded certain other possible methods. In the rush and tumble of dialogue and activity which has produced our current positivist focus, certain "oppositional" entities were identified for their significance in understanding consciousness. For brevity we can list them this way:

Ways of Knowing

Thinking through (in-the-head) Empirical evidence
Direct experience of phenomena Observation and recording of phenomena
Inductive thinking Deductive thinking
Subjectivity Objectivity
In addition, certain propositions were put forth regarding the relationship of experience to the development of consciousness emphasizing especially the Marxian concept of human sensuous nature and the dialectical nature of our action on and with objects. This action, both physical and psychological was proposed as the "substance" which makes self-conscious reflection possible. The role of intuition in establishing certainty and providing a unifying function for consciousness was presented.

Finally, a paradigm for the development of critical consciousness was described linking the idea of the brain as a dissipative structure to its wholistic intuitional capacity and ability to cut through illusion to recognize choices. In the next chapter we will look more deeply at our capacity for choice as an aspect of intuition and its proposed physiological base.
NOTES

1. Although many of the ideas in this paper are thoroughly discussed in the annals of Eastern history and culture I have not attempted to draw such connections. This is partly because that task is beyond the scope of this paper and partly because others are doing it (see Fritjof Capra, The Tao of Physics, NY: Bantam Books, 1975; and Marilyn Ferguson, The Aquarian Conspiracy, Los Angeles: J. P. Tarcher, 1980, as examples).

2. The assumption here is that the assumed principle from which points are deduced is proven already, while those particular points from which a principle is induced are subjectively gathered and not proven. Please see Robert Miller (Meaning and Purpose in the Intact Brain, Oxford: Oxford University Press, 1981) pp. 187-197 for a discussion of deductive and inductive inference and the latter's association with "belief" and the former with "fact."

3. Ollman's description helps here: "Marx uses 'object' in the sense of the 'object of a subject' (real or potential), rather than in the sense of 'material object,' though all of the latter are included in the former and it is material objects which are usually being referred to." From Bertell Ollman, Alienation: Marx's Conception of Man in Capitalist Society (Cambridge: Cambridge University Press, 1971), p. 78.


7. Freire delineates these levels according to their degree of "transitivity" or permeability to the realities of existence. At the magical level people "confuse their perceptions of the objects and challenges of the environment, and fall prey to magical explanations because they cannot apprehend true causality." Naive transitivity is characterized by an "oversimplification of problems;" people are still partly massified and their capacity for dialogical communication is fragile. Critical consciousness tests perceptions and explanations, rejects passivity, accepts responsibility. People become the subjects rather than the objects of history. Paulo Freire, Education for Critical Consciousness (NY: Seabury Press, 1973) pp. 17-18.
CHAPTER III

INTUITION, CHOICE, AND CONSCIOUS UNITY

Introduction

In 1890 William James wrote:

Bodily experiences, therefore, and more particularly brain-experiences, must take a place amongst those conditions of the mental life of which Psychology need take account. The spiritualist and the associationist (psychologist) must both be 'cerebralists,' to the extent at least of admitting that certain peculiarities in the way of working of their own favorite principles are explicable only by the fact that the brain laws are a codeterminant of the result (Ornstein, 1968, p. 9).

Although James saw the importance of the brain and its activities for understanding human behavior, actual study of the "brain laws" is only now, 100 years later, beginning to present itself in a concrete way. In the early 1900's the behavioral school of psychology was establishing itself and would maintain a dominant position at least until World War II (Davidson, 1980, p. 13). Very much in the positivist mode, behaviorism focused only on "...aspects of behavior which were observable and measurable..." contributing, in Davidson's words, "enormously to the improvement in the rigor with which psychological problems were approached and (helping to) place psychology on firmer ground with respect to its scientific status" (p. 1213). At the same time, however, this focus on the measureable aspects of behavior deliberately excluded questions of
consciousness and other "internal mental events" (Davidson p. 13) which might require an introspective approach.

Following World War II, various methodological and technological developments shifted the focus toward concern with internal mechanisms of the body's neurological/biological systems. The ability to trace electrical activity in the brain through use of the electroencephalogram (EEG) and the more recent development of the electron microscope have all contributed to the new burst of energy devoted to studying the brain.

Frequently the question is asked, why study the brain? Is it necessary to understand brain physiology to teach better, to learn better? Of course I believe the answer is yes. If for the moment we consider the brain to be a tool of learning it follows that the better we know how to use the tool the better we learn. Because many have believed that it was not possible to know about the inner workings of consciousness the study of consciousness has either been disregarded (by the behaviorists) or considered the realm of philosophers. Few of us in education have sought to delve into the brain to inform our teaching methods because information was scattered, partly unintelligible in the language of neuroscience, and not absolutely necessary to our daily teaching.

Today information on the brain is becoming more widely available in a form possible to be digested by those of us without formal science background (Rose, 1976). Furthermore, the focus in neurophysiology is, increasingly, to study the whole brain and its work-
ings rather than, as in the past, to focus on the individual chemical and electrical mechanisms of a single nerve cell. Aleksandr Luria, the renowned Soviet pioneer in neuropsychology said in 1973, "It is the work of the brain as an apparatus organizing human mental activity which must be of the most immediate concern to the philosopher and psychologist, the teacher and physician" (p. 342). Cross-fertilization among disciplines in the "hard" sciences is yielding convincing evidence for viewing the brain as a complex of "highly organized systems" (Thompson, Patterson, and Berger 1978, p. 85) (Kornhuber, 1977, p. 330) which contribute to learning and memory. The science of teaching has much to share and much to gain from joining in this interdisciplinary burst of energy. The cost of not knowing how best we learn has already been too great (Hart, 1983, p. 19; Shor, 1980; Tobias, 1978).

Studying the Brain

The attempt to understand the workings of the brain has produced a series of models or paradigms. These paradigms, suggests Stephen Rose, were often reflective of the strongest current of scientific thinking at the time. For example, Descartes' picture of the brain as an hydraulic mechanism fit closely with prevailing Newtonian concepts of the mechanical workings of the world. During the 1800's this system was refined into the "localization" idea of "phrenologists" who proposed that by studying the skull they could pinpoint areas of the brain responsible for such things as caution, destructiveness, self-esteem and that these areas were separate compartments, still in a mechanical mode.
Rose describes the switch from this compartmentalized model where every brain function had its home to, in the 1920's, a signal system much like the telegraph or telephone. He cites a whole section from a children's encyclopedia of the late 1930's which describes the brain as the "executive branch of a big business with a General Manager (your Conscious Self) and many departments connected by telephone lines (Rose, 1976, p. 43).

For a time cybernetics dominated as the brain analogue, looking at brain activities as control systems for managing the flow of information which became action. Most recently, of course, the brain is very often described in terms we associate with computers, the information processing analogy seeming to provide the clearest picture. Another recent explanation comes from the extensive research of Karl Pribram and associates. Pribram's concept of the brain, encompassing the concepts of quantum physics and probability waves, would have us view memory as a holograph. Finally, as discussed in Chapter II, the brain has been described by some as a "dissipative structure" borrowing from Prigogine's thermodynamic paradigm.

Gradually, the analogies become more appropriate as research data increases and methods are refined, and, perhaps, most important, as scientists share information across disciplines and across branches within disciplines (Rose p. 47; Miller, 1981).

The Mind/Brain Question

In addition to this analogical nature of brain study, histori-
cally there have been two ways of describing activity of the brain: as physical activity and as mental activity. As the previous chapter pointed out, this division came about over a long period not only because of ideological debate but also because of limitations on our ability to actually observe or directly experience brain activity.

The following discussion of how the brain works will be shadowed by this division. On one level we will talk about physiological and anatomical functions and on another level, yet referring to the same brain activity, we will talk about mental (and emotional) activity. Neuroscientists, psychologists and philosophers continue this debate over what is usually referred to as the "mind/brain" problem. At an international science symposium in 1977, British neuroscientist, John Eccles, presented a paper entitled "A Critical Appraisal of Brain-Mind Theories." In the paper he outlined major positions on whether mind and brain are the same, totally separate or somewhere in between.

He describes five theories: radical materialism; panpsychism; epiphenomenalism; psychophysical identity and, his own, the dualist-interactionist theory.\(^1\)

The "psychophysical identity theory" comes closest to the position taken here on the relationship between mind and brain. There are, as Eccles says, many variants of this theory and he cites six. We will make use of the descriptions of two neuroscientists in addition to Eccles to get a brief but fuller picture of this way of looking
at consciousness. In Eccles' words part of the psychophysical identity theory stresses that:

Mental processes are real...They are conjectured to be a property of a very small and select group of material objects, namely neural events in the brain...The conscious experiences are known within, knowledge by acquaintance, whereas the 'identical' physical events are known from without by description, knowledge by description, of the neural events in the brain. These events described by the neuroscientist turn out to be the experiences consciously perceived. Thus the key postulate is essentially a parallelism or an inner and outer aspect (Eccles, 1977, p. 349).

A second view of the psycho-physical identity theory is supported by Steven Rose (1976). To deal with the division between mental and physical mind/brain activity, he suggests a hierarchy of several levels or "universes of discourse" with a point on each level corresponding to a point on each level above and below it (See Figure 2). Thus each activity has a corresponding reality at each of the other levels. Rose suggests that the "confusion over the relationship of mind to brain" has arisen because of attempts to discuss an activity at more than one level of discourse at a time. By this he means it is appropriate to assume a correlational relationship between hierarchical levels but not to assume a causal relationship. He gives the example that 'being in love' is a state that may be accompanied by a certain change in molecular structure but that being in love neither causes that change, nor is caused by it (pp. 29-30) He further explains:

...in saying that the mind is the same as the brain at a different level of discourse, I mean that for any event it would be possible to provide two equally valid sets of descriptions, one in 'mind' language, the other in 'brain' language (p. 31).
Figure 2: Hierarchies in Biological Explanation
(Adapted from Steven Rose)
Robert Miller proposes for us a third and somewhat different view of the brain/mind relationship which is called "psychophysical parallelism" and which seems to me to be similar to that of Rose, yet with some helpful elaborations. He maintains, as does Rose, that, given the accepted definition of a causal relationship, it would not make sense to posit such a relationship between what we see when observing brain activity and what we experience directly with the brain. He proposes that we use the concept of a "logical transformation without causal implications" to understand the relationship of subjective to objective reality with which our brains operate. (He gives an example of this type of transformation: "...the process by which geographical landmarks have their correspondence with features on a map of the same area" p. 17).

Miller concludes there to be a parallel nature between the subjective realm mind and the objective realm brain but describes this parallel nature as "...the sort of mapping of a 'field' of information that might be possible in a multidimensional space" (1981, p. 17). Miller goes further than most who identify themselves as psychophysical parallelists in that he proposes constructs which help to understand the unity which seems to characterize our consciousness giving us consistent personalities and relative constancy of purpose. He proposes a unity which can help to match the "objective properties of the brain and the subjective experience of consciousness" (p. 20).
The discussion on the mind/brain division is reminiscent of the oppositional ideas in Chapter II. It has been carried on for centuries and this study does not purport to solve the dilemma. I take the position that consciousness is a process which both affects and is generated by the interaction between matter and energy. It is no longer important to contrast the material against the spiritual or to pit conscious experience against physiological data for the purpose of determining which is more valid. What is important is to examine the relationships between and among identifiable levels of consciousness, as transformation and our experience of those levels, finding a "common denominator" (Kornhuber, 1977, p. 322) among them which can clarify and make accessible to us our capacity for choice and reflection. (Please see Figure 3).

The Case for Intuition

Recent research regarding the possibly separate functions of the left and right hemispheres of the brain has given prominence to the discussion of intuitive capacity and its relationship to various kinds of human activity. Research also indicates that the two hemispheres of the brain seem to house fairly distinct functions. (Please see Figure 4b). However, there is a great deal of fuzziness about how much separate control each hemisphere has over its various domains. This is due to the existence of the corpus callosum, a neural 'channel' between the two hemispheres which seems in most cases to provide both sides of the brain with the same information no matter which side of the body is stimulated.
Figure 3: Levels of Experience and Transformation
Figure 4: The Brain
(Adapted from Steven Rose)
Therefore it seems that it might also be rather difficult to ex-
actly separate which part of the brain is thinking rationally and
which part is thinking intuitively, particularly when most activities
require some of both. Consequently, although it may be true that
intuitive and analytical functions can originate in separate hemi-
spheres, I believe the distinction can be misleading. Individuals
begin to identify themselves as being right or left brain dominant
with a kind of pathological attitude about ever being able to per-
form functions controlled on their recessive side.

I prefer an explanation of intuition which suggests that it is
not located in a separate part of the brain or even necessarily a
separate function, but that intuitive processes constitute the to-
tality of conscious activity. That is, what we refer to as intuition
is in fact the overall organizing element which accounts for the
"unity of consciousness" (Miller, 1981, p. 192) and the "combined
workings of all...brain units" (Luria, 1973, p. 99).

I believe it is safe to say that nearly every brain process for
which we cannot readily account is ascribed to intuition. Creativ-
ity, psychic prediction, accurate guessing are among the many un-
explained phenomena of consciousness which have been ascribed to
intuition. Our ability to define intuitive processes was enhanced,
perhaps indirectly by split-brain research, when attempts were be-
gun to differentiate between capacities of the major brain hemi-
spheres. Right brain or intuitive functions were said to include
pattern recognition, spatial or nonverbal thought, kinesthetic sense
and musical ability (Bogen, 1973, pp. 103-4). While the left hemisphere "measures, compartmentalizes, organizes and pigeonholes," the right "thinks in images, sees in wholes..." and helps us to "learn, create, and innovate" (Ferguson, 1980, pp. 789).

In this chapter we will attempt to refine the definition of intuition and demonstrate a physiological basis for the role to be described. In Chapter IV the related functions of reflection and choice will be described in similar fashion.

**Matching the Paradigm: Wholistic and Interactive**

In Chapter I we suggested that human consciousness has developed both a critical and an illusory function and that while the latter was useful for us in interacting with our environment to survive, it has, perhaps, developed to the detriment of the former. How this happened may remain the secret of evolution but we can speculate that our interaction with nature affected our perception of reality causing us to see the rocks and trees and earth in these forms, helpful to us for our survival. It seems contradictory that this function of consciousness which helps to create illusion should now be our analytical, organizing agent (left brain) and that the critical function so close to extinction should be the wholistic, (right brain) unifying agent.

Henri Bergson describes it this way, according to Malcolm Westcott:

The prime reality is movement, change, evolution, interaction—a dynamic flux which proceeds along a definite but unpredictable course. The prime reality is...'the perpetual happening' or... 'duration.' The mind...is shielded from the perpetual happening by the intellect, which imposes 'patterned immobility' on prime
reality, distorting, immobilizing, and separating it into discrete objects, events, and processes. In the perpetual happening itself, all events, objects and processes are unified (Westcott, 1968, p.8).

And,

Through intuition (we) may attain that which was lost: intuition is the attainment of direct contact with prime reality, direct experience of the perpetual happening, and nonintellectual contact with pure duration (p.8).

Finally,

...intuition is an experiential event...unrestrained by reason... (and) can be sought and encouraged by divesting oneself of restrictions imposed by the intellect... (p.10).

Although Bergson's description suggests employing intuition for direct contact with "pure duration" the scope here will not encompass mystical or transcendental experience. Our aim is to demonstrate the link between intuitive processes and our capacity for self-conscious or subjective awareness of our own thought and behavior. Hence, although there may seem an affinity between "analytical" left hemisphere processes and "critical" consciousness, we need to understand critical as being aware of the whole, as an expanding awareness rather than a narrowing one. The left brain sees the details and organizes them into patterns we are used to. The right sees the whole in new, sometimes startling ways (in dreams, images, artwork).

Once again, although it is comfortable to use these right-left distinctions for describing the different functions, the fact remains they are functions of consciousness as a whole (functions of the brain as a whole). Therefore, although Bergson describes intuition
as "unrestrained by reason" our intuitive capacity encompasses reason, logic, and other analytical types of thinking but sidesteps them in its process. The two sides of the chart of "ways of knowing" in Chapter II should also be viewed as interactive parts of the whole of consciousness.

Intuitive processes have long been associated with the creative arts (Gardner, 1982; Ghiselin, 1952) and, perhaps less popularly, with natural science. In spite of the downplay of subjective experience in scientific investigation, in 1959, Jerome Bruner, psychologist and educator, was invited to a gathering of scientists to discuss how to improve the teaching of science in schools. The scientists stressed the importance of intuitive thinking, as well they might. Early in the 20th century, earthshaking discoveries in mathematics and science had their roots in intuitive thinking. Jules Henri Poincaré, a mathematician who revelled in "...the harmony of numbers and forms...(the) true esthetic feeling that all real mathematicians know..." described the creative process of mathematics this way:

Now, what are the mathematic entities to which we attribute this character of beauty and elegance, and which are capable of developing in us a sort of esthetic emotion? They are those whose elements are harmoniously disposed so that the mind without effort can embrace their totality while realizing the details (Poincaré, 1952, p. 40). (my emphasis)

When asked to describe what mental images of words were part of his discovery process, Albert Einstein wrote:

...words or...language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The
physical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be 'voluntarily' reproduced and combined...this combinatory play seems to be the essential feature in productive thought - before there is any connection with logical construction in words or other kinds of signs which can be communicated to others" (Einstein, 1952, p. 43).

Yet, as with the Theory of Relativity, once the image was clear, the experiments imagined in the head, as with Poincaré, the details were realizable and able to be set down in mathematical formulation to "prove" the theory. With evidence of this nature, intuition gained a respectable position in scientific endeavor. Physicist Fritjof Capra supports the point: "The rational part of research would, in fact, be useless if it were not complemented by the intuition that gives scientists new insights and makes them creative" (Capra, 1975, p. 18).

As philosophers continued to refine their concepts of intuition we discover a relationship to belief: "...in all acts of reason there is an element of intuition...there is the belief in certain self-evident truths..." (Westcott, 1968, p.19) reminiscent of Miller's description of inductive thinking in Chapter II. Acknowledging that reason is therefore based on something that is subjectively known or believed opened the way for intuition to be viewed as a kind of inference. This implied that knowledge based on intuition could be tested, made clearer by reasoning and hence verified or dispelled, according to Ewing (Westcott, p.19). This recognition of intuitive processes in the scientific method has required a special adjustment in terms in order for intuition to fit within the positivist mold. Intuition
became known in the natural sciences and psychology as "inductive inference."

**Intuition as Inference**

Westcott reports that in general in psychological explanations for intuition there have been three interpretations: Jungian, intuition as inference, and the Verstehenist or "global understanding" version. (1968, p. 185) On the one hand, while Jung saw intuition as a "simple given function of humans" he also suggested that the "unconscious process of...mankind" could be a source for intuitive knowledge which could have universal implications for our lives (Westcott, pp. 1868).

Among the explanations offered by psychologists who linked intuition to inference certain characteristics appear with regularity. Intuitive thinking deals with a complexity of inputs that often seem beyond organized explanation, for example in formulating theory as in the Einstein example. Intuitive thinking is also characterized by extremely rapid coding or categorizing of this complex material (Westcott, p.42). Third, a feeling and conviction of certainty based upon the "knowledge of acquaintance" or subjective, internal information of the act itself accompanies the intuitive process. Poincaré has described this as the feeling which accompanies the "apprehension of a discovery" (Westcott, p. 50).

In addition to complexity, rapidity and certainty, intuition arrives at its conclusions without knowing how. This "unknown" quality has been described as the "unconscious use of unconscious
cues" (Westcott, p. 46). This leads to the debate about whether intuitive processes are available to awareness or not. In linking intuition to inference, Westcott believes that the main difference is that in inferential thinking the process by which one reached a conclusion can be remembered and told to someone else, hence analyzed for inconsistency. Intuitive thinking, however, is generally not available in this way. It is this "obscurity or inexplicitness combined with accuracy" which makes intuition a "special case of inference." This definition offers a view to the total perspective of the inferential position:

Intuition as a form of inference behavior is based on inexplicit sensory data, rapidly and inexplicitly combined, leading to plausible or correct conclusions with the subject being unable to specify how the conclusion was reached (Westcott, p. 78).

Finally, intuitive thinking is also characterized as having a predictive quality which, in a sense, "qualified" it for becoming a case of inferential thinking.

Each of these characteristics of complexity, rapidity, certainty, unconsciousness, and prediction have significance for our discussion of intuition, although some will receive more attention than others. In looking at intuition as a critical function with a wholistic perspective, able to tap the totality of the complex of highly organized systems which some see consciousness to be, we are concerned with the physiological activity which accompanies this process and the ability to be aware of some aspects of this intuitive process. Gordon Allport, in his work on analyzing personality, arrived at this description of intuition as inference:
It almost appears that understanding, that is patterned perception, is the event of placing one's various inferences... into a network of interlocking hierarchies which yields a high degree of predictive success and esthetic satisfaction (Westcott, p. 32).

In line with this view of intuition as being able to link perceptions with the "network of interlocking hierarchies" that are the contents of consciousness we will next consider the importance of perception in making use of our intuitive capacity.

**Perception - A Kind of Choosing**

In his theory of personality, Jung referred to sensation and intuition as two of the four "mental functions constitutionally present in all individuals" (Westcott, p. 32). While sensation was described as perceiving sensory detail through reception of sense data from the internal and external world, intuition he defined as the "perception of possibilities, implications, principles, and objects as totalities (at the expense of details)" (Westcott, p. 33). Now we will look at the form of perception attributed to sensation, looking at the very particular and microcosmic level of the neuronal activity which accompanies our ability to perceive.

**The Neuron - A Unit of Transformation**

The basic physical component in the brain's transformation system is the nerve cell or neuron. As Figure 6 illustrates, its major components are the dendrites, the cell body, the axon, nodes, and the synapse which connects with the next neuron, or in the case of this diagram, with a muscle. In addition to these nerve parts, numerous chemical elements and compounds are involved in
Figure 6: The Neuron
the information flow, including the elements sodium and potassium, as well as various 'transmitter substances' which function at the synapse.

Like most other cells in the body, the brain cell has what is called a resting membrane potential due to the uneven distribution along its various parts (dendrite, body, axon, synapse) of sodium and potassium ions. The unique aspect of most brain cells is that they are excitable. That is, they have the capacity to conduct what is called an action potential, a pulse of electricity which passes from the dendrite or cell body all the way through the axon to the myriad of synaptic connections impinging on the entire cell.

In order to trace a "message" through the brain's systems we can take a very simplified example. In this case, let's say the original external stimulus comes through the eyes in the form of a figure walking toward you. Light striking the person is reflected and enters your eyes, slowing down and bending as it passes through the lens in your eye. The bent light continues on its journey till it strikes the retina where these quanta of energy or "photons" then pile up in the same order (albeit upsidedown!) as you first viewed the figure. This light energy is received at the retina (a thin sheet of nerve cells) by receptor nerve cells called rods and cones. And here the visual information begins to be translated into the electrical language of the nervous system. (This early processing of visual information by the retina has caused the retina to be described as an "outgrowth of the brain" itself) (Gregory, 1966, p. 44).
At the psychological level we can now imagine how our powers of perception are involved in this process of transforming light energy into meaning and action in our brains. Some view perception as the beginning of a process of reducing uncertainty. The stimuli or information received through the senses present us with a degree of uncertainty or complexity (Smith 1975, Bruner 1971) about what is going on around and within us. Our sensory mechanisms are actually very highly adapted to perform this function. The senses are tuned to take in information which is necessary for our survival at the moment and this is usually done without our being quite conscious of it. Driving is a good example. And though it appears that we as humans are continuing to adapt to greater and greater complexity in our surroundings, there is a significant proportion of "information" or stimuli in our worldly surround which we do not sense or pay attention to consciously. Probably the example most often given is the limitation of our visual sense in perceiving the wide range of electromagnetic waves which represent energy transfer in the universe. We see only the tiny band indicated on the spectrum in Figure 7. Such a "limitation" need not be viewed as negative, nor even as rigid, since there are many examples of training the eye to see what was previously not visible (e.g., combinations of colors an artist perceives which I do not, night vision, auras). However, this type of limitation points out how perception can be considered a part of our illusory function. We see what has been most helpful for us to see as part of evolution.
The electromagnetic spectrum reveals the narrow range of radiation visible to man's eye. From the standpoint of physics, the only difference between radio waves, visible light, and such high-frequency forms of radiation as X-rays and gamma rays lies in their wavelength. But out of this vast range of electromagnetic radiation, extending from cosmic rays with wave lengths of only one trillionth of a centimeter up to infinitely long radio waves, the human eye selects only the narrow band indicated in white on the above chart. Man's perceptions of the universe in which he dwells are thus restricted by the limitations of his visual sense. Wave lengths are indicated on the chart by the denary system: i.e., $10^3$ centimeters equals $10 \times 10 \times 10$ equals 1,000; and $10^{-3}$ equals $1/10 \times 1/10 \times 1/10$ equals $1/1,000$. (Barnett, 1948, p. 21)
and our interaction with our environment. We are used to believing that we see all there is to see. However, when someone proves that we just missed seeing that person standing two feet away, we accept that we "weren't paying attention," or our minds were "somewhere else." This selective function of perception has been explained by Luria:

Perception...is an active process which includes the search for the most important elements of information, their comparison with each other, the creation of a hypothesis concerning the meaning of the information as a whole, and the verification of this hypothesis by comparing it with the original features of the object perceived. The more complex the object perceived, and the less familiar it is, the more detailed this perceptual activity will be (1973, p. 240).

This hypothesis-testing idea is supported by R. L. Gregory. He gives the example of looking at an "ambiguous figure" such as the one seen in Figure 8 and trying to understand exactly how it goes since it keeps defying what we expect. "Perception," he says, "changes spontaneously, from moment to moment, as various orientations... are selected as hypotheses of reality...", i.e., of what the figure really is (1978, p. 221).

Our role in choosing what we see through this hypothesis testing process represents one of the major adjustments in psychological theory away from the behavioral approach and toward the cognitive. Perception, which used to be viewed as a "...passive imprint made by external stimuli on the retina...and the visual cortex" (Luria, 1973, p. 229) is instead a complex combination of "imagining, thinking, and remembering" (Neisser, 1982, p. 45) in which we anticipate what we are going to see and draw on our past experience to
Figure 8: Ambiguous Figure
(Adapted from Robert Gregory)
interpret. This new understanding has major significance for the
development of the critical function of consciousness. The role of
choice in perceiving, imagining, and attending is accepted as a
given in the cognitive approach.

...all versions of cognitive psychology agree, at least implicitly,
that people choose much of what they know. The choices are
made in many ways: through selective attention...the acquisi-
tion of cognitive skills...we are largely responsible for what
we come to know (Neisser, 1982, p. 45).

If it is true that we are responsible for what we know, that
in adapting to our environment for survival we construct our own
reality (Davidson, 1980, p.13), is it possible to become conscious
of how we do this and to intervene to change our perceptions when
they are no longer helpful? Evidence supports a positive answer
to this question. The following description of how neurons assist
in "discriminating" in order to make sense and the accompanying
interpretation of the synapse as a construct which makes choice
possible will help to explain our potential for self-consciously direct-
ing action. For although much of the information processing that
accompanies our attempt to make meaning

proceeds in the absence of conscious awareness...and although
many cognitive psychologists have assumed these structures to
be relatively static and fixed in the constraints they impose on
our cognitive competence, recent evidence indicates that with
appropriate, intensive practice, the constraints that these
structures impose can be significantly modified (Davidson,
1980, p. 18).

In particular, where perception is concerned, this paper proposes
that attending can be enhanced through skill practice to increase
our awareness of and ability to influence perception and learning
in general.
As we continue with our message along its physiological path, we discover how choice occurs at this level as well. In its electrical form, the original stimulus created by light reflecting off the person walking toward us and entering our eyes is now broken up a bit as each of numerous sets of neurons analyzes it for certain information. These sets of nerve cells each have a particular coding or translating function to further refine the message. As the message, or what is now a series of signals, travels from one set of neurons to another, it does so by jumping a gap between nerve cells. This gap is called the synapse.

The Synapse - A Space for Transformation and Choice

As we shall see in subsequent pages, the synapse holds a special place in the structure of consciousness. It is to the synapse

...that we must look to begin to introduce that element of variety which must be the key to the nervous system, which must distinguish it from an inevitable system in which, for a given input, there is an invariant output of response. For it is at the synapses that it will be decided whether or not the next cell will fire in its turn (Rose 1976, pp. 78-79).

It is estimated that synaptic space comprises about 10 percent of the total volume of the brain (Rose, p.68) and at these numerous junctures along each nerve cell another transforming process occurs.

The electrical message becomes a chemical one.

When the action potential travelling along the axon reaches the presynaptic area it is translated into a signal which releases a chemical transmitter substance from tiny synaptic vesicles. Whereas the nature of the axon throughout its total length is to continue
firing, the synapse exercises control. It can "say No as well as Yes" sending either an excitatory or inhibitory impulse, as described above. The choice of whether to fire or not is apparently made at the post-synaptic point, that is, the point on the next cell where the chemical message is received. Our poor tired message is then carried across the synaptic cleft (please see Figure 9) and is received by receptor molecules which translate the message back into an electrical pulse for its journey through the dendrite, cell body and axon of the next neuron. The next neuron analyzes the sum of impulses it may be receiving along its various parts, weighs the most important and fires accordingly. In emphasizing the importance of the "choice point," Rose says, "Consciousness, learning, and intelligence are all synapse-dependent. It is not too strong to say that the evolution of humanity followed the evolution of the synapse" (Rose, 1976, p. 79).

J. Z. Young also views what happens at the cellular level as choosing. He gives the example of bacteria in a new environment selecting an enzyme from among those their DNA allows them to produce in order to make food from the new environment.

What is important for us is to see that the whole cell is involved in a process of detection, communication, and then selection from a set of possible actions. This process is similar in principle to the vastly more complex acts of choice that we ourselves make... All choice depends upon selecting among a set of possible actions (Young, 1978, p. 19).

The opportunities for "choice" at synaptic points is, perhaps, infinite. All axons have numerous branchings which connect with
Figure 9: Synapse and Synaptic Cleft (Adapted from Steven Rose)
other neurons. Impulses received in the axon travel to all of these branches. At the same time the dendrites of each cell make connections with myraids of other neurons and receive or potentially receive impulses from them. These synaptic connections have been measured in the hundreds or thousands, the largest number recorded on one nerve cell being around 80,000 (Eccles, 1973, p. 103)

But how does a message get through this mass of electrical/chemical activity? It is often useful to think of part of the transformation process of the brain as one of coding, classifying and storing information. Thinking of electrical and chemical activity as information can help unify this multi-level picture of consciousness we are painting. Kornhuber suggests that although psychic and physiological processes may not be the same, they do have the same "information content" (1977, p. 322). Perhaps he states this with such certainty because of the advances which have occurred in analyzing the coding and classifying mechanisms of the brain (Rose, 1976, pp. 131-4).

Information Processing

As we have seen, there is an immense amount of activity going on in the brain. If we consider that there are some $10^{11}$ (Teyler, 1978, p. 48) brain cells in the average brain with all of them active all the time, the problem is compounded. The challenge for consciousness is to derive meaning from this constant and multidimensional "noise."
As Eccles says:

...there is almost always background firing of neurons...

Even when you are asleep the neurons of your cerebral cortex are firing impulses. Actually some fire even faster when you are asleep than when you are awake. The problem is to extract a reliable performance out of the nervous system, considering that it has so much background noise (Eccles, 1973, p. 103).

Extracting reliable performance is made possible by a certain columnar arrangement of cells, the same species or kinds of neurons are organized together in groups receiving and transmitting the type of message specific to its genetic and chemical make-up. Having one neuron fire an impulse would not work—the message would be "lost." These groups or clusters of similar neurons serve to amplify a signal, "shout(ing) together" to get the signal to the next cluster, and so on until the impulses of these and other clusters spread "meaningful signals widely and selectively in the cerebral cortex" that scientists believe are what result in conscious experience (Eccles, 1973, p. 98).

Eccles emphasizes that this columnar arrangement also provides what he calls a "discriminatory judgment" in helping to transmit a strong and meaningful signal. This is accomplished through an intricate mechanism called inhibition, briefly referred to above. Nerve cells that accomplish inhibition are specially designed and make use of unique transmitter substances, different from those of excitatory neurons. In contrast to the neuron described above, they do not generate impulses and are usually without axons (Pribram, 1980, p. 48). The inhibitory cells work through a kind
of feedback system which helps to keep down the level of excitation of neurons not involved in the particular body motion or brain activity trying to be accomplished. They somehow "know" to suppress discharges from more weakly charging cells. The most intense excitatory impulses are thus accompanied by these helper inhibitory impulses which suppress others in the nearby area, or "surround." Thus we are able to stand with knees bent because inhibitory neurons keep flexor muscles from contracting. Or, in the case of the person walking toward us, we see (or do not see) the person depending on the competing messages (people, traffic) entering our sensory system.

By this time our message will have arrived at the cells of the brain called the visual cortex where higher order analysis is performed and final interpretations and storage occur. Here we approach the structures of consciousness which underlie the unifying process of intuition. Miller stresses that meaning is a network of bits of information, a "...complex structure...in which prolific interrelationships are the essence" (1981, p. 50). He further specifies that there is a spatial and temporal nature to the acquisition of meaning which is what eventually constitutes both short and long term memory. Meaning in his interpretation is "a clustering of statistically significant associations in space and time" (p. 65). Whether or not the message we receive is stored as knowledge (and hence can be viewed as learning) depends on a complex system of association with other messages which will be described below when we discuss the storage of information.
This vast network of neuronal circuitry has been described as "omniconnected" (Miller, p.181), "multipotential" (John, 1980, Chap.6) and holographic (Pribram, 1980, Chap. 3). Such could be the source of much of what we do not understand about intuitive thinking, of all thinking for that matter. Such a structure implies that within the brain there is a "...diffusely connected neural network" where every neuron has the potential to influence every other. This does not imply that every neuron is physically connected to every other but that each has access to the others through electrical and chemical transmission. Hence, the possibility for categorizing and associating which creates our store of knowledge.

Information Storage

The Symbolic Transformation

Deriving meaning at the cognitive level can be seen to involve, then, the coding and classifying or categorizing of information for storage in a vast network of neuronal connections. We can recall the example of the person moving toward us. Now, whether you immediately store the message and 'forget' about it, or whether you think on who this might be, or whether you otherwise act on this information, it remains that somehow, the configuration of light energy which entered your eyes has now come to represent the concept in your consciousness of another being like yourself. How does the "shouting" that your nerve cells are doing become an image, perhaps a word in your consciousness, symbolically representing the person approaching you?
When we consider this picture of what happens in the brain, i.e., the "mental" picture, the role of language in meaning becomes most evident. This ability of the brain to transform energy into the symbolic or sign systems of language and mathematics is linked directly to human experience both through action on external objects and through our perception of those objects. Without attempting a detailed discussion of this aspect of transformation, this section looks at our capacity for imagery and its link to intuitive processes.

For Caleb Gattegno, founder and proponent of the "silent way" method of language teaching, understanding language involves understanding perception as the "true contact(s) between our selves and the environment" (1976, p. 33). The certainty or meaning associated with words, he says, comes from

the actual energy changes experienced by our system when it is submitted to either mechanical impacts (including those...[on our] eardrums), or electromagnetic impacts (including the photons that reach our retina), or heat and chemical impacts on our nerve endings (p. 33).

The impact of these "inputs of energy from the cosmos" as Gattegno calls them (p. 33) stimulate receptors (in the eyes, for example) which are coded to understand and transmit shape, color, density, and movement (Gregory, 1966). Each different species of nerve cell carries one specific bit of information regarding a particular feature of what we see (Young, 1978, p. 50), say the color of the coat of someone walking toward us. Similarly, the sounds which come to us both from the outside and from our own vocal
cords are experienced and coded for our use. These perceptions of sight and sound become associated in the formation of images (Gattegno, p. 35).

However, images do not seem to be the result only of perceptual experience, but also of "practical activity" (Vygotsky, 1978).

The most significant moment in the course of intellectual development...occurs when speech and practical activity, two previously completely independent lines of development, converge (Vygotsky, p. 24).

In analyzing the origins of speech Vygotsky's research indicated that sometimes if kept from speaking, a child was not able to accomplish a task. He says that speech and action or problem solving are part of the same psychological function. And, that this "...unity of perception, speech, and action...ultimately produces internalization of the visual field..." (p. 26). This is the Piagetian stage of "preoperational thought" when language and ideas begin to merge (Wadsworth, 1971).

The ability to construct images inside our heads of the world outside allows us to plan, to dream, to reconstruct happenings from the past, to be aware of expectations. The ability to solve problems by visualizing more than verbalizing has been identified as an intuitive cognitive style (Bastick, 1982, p. 192) which makes use of a kind of "shorthand intermingled with organized thinking" (C. Farmer, 1961, quoted in Bastick, p. 191). Imagery can be viewed, then, as a quicker way of retrieving information from an interconnected store of knowledge.
The Distributed Store

What is most significant for us, eventually, is to get a clearer idea of just how this retrieval of information from memory is accomplished. Therefore it is important to look a bit more closely at how it might be stored. At one time, it was believed that memory was localized in specific parts of the brain. That is, information received and stored by a particular set of neurons would remain in the location of those neurons. Such a concentration of information was called an "engram." Evidence indicates, however, that information is probably stored diffusely or perhaps in sets, corresponding to interacting brain systems (Thompson, Berger, and Berry, 1980, p. 222). Thus it seems that memories of specific ideas or events can often be found to be stored "...over a wide extent of tissue" (Pribram, 1978, p. 149). Pribram refers to this aspect of memory as the "distributed store." From another perspective, but with similar conclusions, E. Roy John presents what he calls a "statistical configuration theory" which proposes that

...information is diffusely available to most, if not all, brain regions...(and) is represented not by activity in a specific neuron or a selected pathway, but by the average temporal pattern of firing in anatomically extensive populations or neurons. The activity of any neuron...is significant only insofar as it contributes to the average behavior of the ensemble, to the statistical process (John, 1980, p. 131).

John refers to this characteristic as the "multipotentiality" of the brain. He says that while the same message may be stored at various sites in the brain, retrieval will most likely be accomplished from that site where the "signal-to-noise" ratio is highest; that
is, where, as we described earlier, the impulses of a particular message have succeeded the best at inhibiting all others in the surround.

It is generally accepted that the greater the frequency of an impulse the stronger it is, hence the better chance of making it through the noise of surrounding, constantly firing nerve cells (Miller, 1981, Eccles, 1873). Thus, in order to hear, see, smell, taste and make sense out of our experience we depend on the brain to "...perform complex calculations on the frequencies of the data it receives" (Ferguson, 1980, p. 179). If we think back to the person walking toward us, our understanding of that person's identity will be based on an incredibly intricate system of impulses, calculations and selections by the nervous system in our heads.

Space and Time in the Distributed Store

The fact that decades of brain research have not produced the location of an engram (a static gathering of neurons representing a specific memory) at any one time in any one place has striking similarity to the difficulty Heisenberg illustrated of measuring both the location and speed of a subatomic particle at the same time. That is, although memory associated with a certain skill would have been expected to be housed in the area of the brain where that function primarily resides (i.e., speech in the left hemisphere) patients whose brains had been damaged in that area were able to perform the skill without difficulty after some practice. This capacity is referred to as redundancy of function (Rose, 1976; Routtenberg, 1980).
The fact of redundancy makes it impossible to think of a knowledge store where happenings of the past are recorded as they happen and remain that way undisturbed and in one location until we call them forth. This is, however, how most people view memory - as a static record of things past. I suggest that it is the illusory, particulate, organizing function of consciousness which creates for us this linear concept of time where things happen to us one after the other and are recorded in that same order in the knowledge store. This is a level of reality at which we normally operate. However, another level of reality must be considered if we are to understand the critical wholistic function of consciousness.

We recall our earlier discussion of the Kantian view of consciousness from which Miller draws support for his conclusion that intuition (inductive inference) allows us to recognize spatial and temporal patterns (Chapter II). These patterns in space and time are not linear, however, but probabilistic. That is, our intuitive capacity is capable of "viewing" all that happens to us, our recorded experience, as a whole, rather than in particular pieces. This wholistic recognition, however, is not usually directly available to consciousness, hence the linear concept of time (past, present, future) dominates our daily reality. This picture of reality is most helpful for our daily activities. However, if a portion of our brain were to be damaged, we would be glad to rely on this wholistic capacity for "recalling" information supposedly stored in the damaged area.
To explain this capacity, Karl Pribram (1978, 1980) has proposed the analogy of the hologram, a three-dimensional projection of "points of information" which represents "occurrences" by themselves rather than something which happened at a particular time and is therefore stored in spatial relation to other happenings. These occurrences have no space/time dimension as we are used to thinking of them,* yet through the integrative capacity of both illusory and critical functions we are able to recall bits of information to reconstruct occurrences as they might have happened.

The further significance of the holographic explanation for information storage lies in its image-making capacity. Pribram states that research has been done which indicates that not only visual but auditory, kinesthetic, and gustatory images are also created in holographic form within the brain (1980, p.60). Thus the results of our experience through the senses, i.e., our perceptions, can become images in our consciousness which lead to thought and language. Further, holographic storage of information permits an "astronomic" number of neural connections to form a network of internal relationships which are a source for mental imagery and thought (Miller, 1981). This picture of how the brain makes meaning out of experience indeed presents a probabilistic picture of consciousness as a "quantum process". But it is a process characterized by a probability which conveys potential rather than randomness.

*In Heisenberg's words they are "something in the middle between the idea of an event and the actual event" (Zukav, 1979, p. 66)
Summary

This chapter has attempted to present both psychological and physiological explanations of how we choose in perceiving and deriving meaning. This "choosing" - that is, the acceptance of one alternative at a time above many which are possible - has, as we have seen, explanations in both "mind" and "brain" language, to use Rose's terms. Recognition of this ability as an innate capacity is a necessary part of achieving self-consciousness about our actions and developing critical consciousness.

Secondly, the chapter has presented evidence for viewing memory, or as we prefer to call it, the store of knowledge in neural circuitry, as a multiconnected system. The storage of information in this system is viewed as a process of preparation for synthesis (retrieval) at a later time; an activity which can be viewed as part of our intuitive capacity to have access to the complete store, access at any one time to the whole of information in our consciousness.

This view of consciousness supports the possibility of developing our critical capacity for viewing the whole and for synthesizing "old" information in a "new" way as opposed to emphasizing our illusory capacity which makes use of the same combinations (habitual thoughts) in the same old way.

The next chapter will elaborate on the method of synthesizing or retrieving new information from the distributed store as a way of making use of our unique intuitive capacity with emphasis on the capacity for imagery.
NOTES

1. For contrast here is an example of what is generally categorized as dualist theory. In this view generated by Eccles and Karl Popper, World 1 of consciousness consists of physical objects and states (inorganic matter, biology and artifacts). World 2 is states of consciousness or subjective knowledge through experience. World 3 is knowledge in the objective sense obtained through cultural heritage and theoretical systems. World 2 is our primary reality and World 1 a secondary reality or a derivative world. There is constant interaction between these two worlds. A key element in Eccles' design is the existence of a "liaison brain" which gives us conscious experience. It assists communication between Worlds 1 and 2. World 3 is experienced by a complex pathway through World 1, hence it also depends on the liaison which when results in thoughts that lead to action "...and so to the operation of free will." Eccles calls himself a "trialist" rather than a dualist because of the three worlds nature of this view. Eccles, John, The Understanding of the Brain, (NY: McGraw-Hill Book Company) pp. 1967.

2. Miller tells us that his representation of neural interconnection is based upon concepts from Gestalt psychology, "namely a set of parts whose essence and unity is defined by the structure of a large number of relationships between the parts." Further, any "...portion of information which is subjectively recognizable contains, in essence, not only a number of individual items of information, but also a much larger number of interrelationships between the different items...the whole is greater than the sum of the parts." Ibid., pp. 49-50.

3. Holography is a photographic technique first developed by Dennis Gabor (1948) in an attempt to improve the electron microscope. Although it is described as photographic, holography makes it possible to create a photographic image, a picture, without the use of a lens and instead using an arrangement of laser beam, mirror, object and photographic plate. The laser beam is significant in its difference from "regular" light. Laser light is coherent, that is, the waves of light which make up its beam all have the same wavelength (also referred to as monochromatic). In creating a holographic image part of a laser beam is directed toward an object while the other part of the beam is reflected off a mirror onto a photographic plate. The part of the laser directed toward the object is reflected, refracted and scattered off the surfaces of the object and also arrives on the same plate. This plate then contains a record of all of the "optical" or amplitude and wavelength (phase) information of the object.

A three dimensional holographic image can be created by beaming another laser through the film made from the plate above. It is three dimensional because of the unique characteristic in holography that all of the possible optical information about the object has been recorded on the plate. Regular photographs usually record amplitude information but not phase information. Hence the image can be visible in the air some distance from the actual object and appear to be "real." (Information obtained from World Book and Encyclopaedia Britannica.)
CHAPTER IV

TRAINING INTUITION

Introduction

In the previous chapter we considered both physiological and psychological evidence for viewing intuition as a unifying function of consciousness through which critical consciousness can be developed. In order to create an integrated picture of brain/mind workings we followed a "message" through a very simplified version of physiological and psychological processes. On that journey three important factors emerged: the major role of perception as our way of directly experiencing input from the world outside our bodies; how choosing is an activity which occurs at many levels in our physical and mental selves; and how the proposed probabilistic nature of imagery provides unique access to our store of knowledge.

This chapter will build on these capacities for choice and imagery as it describes the physiology and practice of training intuition and the possibilities of self-conscious, subjective knowing.

The Nature of Experience - A Second Look

In Chapter II experience was described as a dialectic activity wherein we both act on something to change it and are changed ourselves. The change in ourselves will concern us most in this section as we seek evidence for physiological change that can be monitored at the psychological level. Such monitoring or awareness underlies our capacity for self-conscious, subjective knowing.
Plasticity

At its most basic level we have defined learning (Chapter I) as "changing through experience." There is substantial evidence that the change "in ourselves" which occurs as a result of this learning is detectable at many levels. Neuroscientists agree that brain activity is detectable and measurable:

...everything that goes on in your brain has a basis in neuronal events and can be measured in terms of signals which by synaptic operations fire neurons...in complex organizational patterns (Eccles, 1973, p. 104).

Learning is also detectable over time, as a process, at neurophysiological, biological, and anatomical levels (Rose, 1976, p. 238); and, I would add, at the psychological and social levels.

To understand these levels of change we return, notably, to the locus of choice in our internal universe: the synapse. Here research indicates a dramatic example of the capacity for change as a result of learning. In neurophysiological terms this change is referred to as plasticity, as mentioned in Chapter II. Steven Rose offers this description of plasticity at behavioral and neuronal levels:

At the behavioural level, plasticity means the capacity of the individual to learn, to be modified, by experience. At the neuronal level we must expect to find the brain's modified experience expressed in terms of a modification of biochemistry, of cellular architecture and connectivity, of the electrical responses of the brain (1976, p. 213).

Although the collections of nerve cells which are responsible for specific features and which shout as a unit to make themselves heard seem not to be able to change, what does apparently change is the synaptic connections each of these nerve cells makes with their neighbors (Eccles, 1973).
Evidence from experiments with animals learning new activities indicate that a synapse can generate new connections and that totally new synapses can be generated from the nerve cell (please see Figure 10) (Lynch and Wells, 1978).

This concept of the "modifiable" synapse is believed to be the microlevel structure which makes possible the storage of information gained from experience, hence the recording of change occurring from experience, hence learning (Eccles, 1973; Miller, 1981). The difference between short-term and long-term memory is proposed to depend on the length of time of neural impulses transmitting information. Synaptic growth (enabling long-term storage) is thought to require anywhere from 30 minutes to 3 hours of electrical and chemical activity. Evidence indicates that protein synthesis (the production of RNA) must also accompany this change at the synapse (Eccles, 1973, p. 185).

When considering the changes which occur at this physiological level over possibly millions of neuronal sites when we are experiencing, doing, thinking, it becomes easy to understand why learning takes energy, a healthy environment and a nutritionally sound body. It is important to recognize that although we are all born with the marvelously intricate capacities described here, maintenance of supportive learning conditions require attention to all the details of the learning process. Attention to the totality of the educational setting will be given later in this chapter.
Change in Size

New Connections

1: Original state
2+3: Changes

Figure 10: Synaptic Change
Self-Consciousness and Subjective Knowing

We can now consider the possibilities of being aware of the collective experience of plasticity at other levels of our body systems. We have defined self-consciousness as an internal awareness of physical and psychological processes. Gattegno colorfully describes this capacity as he explains how he believes we generate speech:

...each of us, drowned in reality and knowing truth directly can acknowledge that there is no truth in words but that there is truth in the consistency of the appearance of some words and some events affecting us. Because we learn as babies to talk to ourselves...we know intimately that our vocal system can be linked to our hearing system and that we can transmute sounds made by ourselves into sounds heard and manage to peel off words from the voices we hear, including our own. The mental-physiological reality of words comes to us from the work we do in our crib, first with ourselves and later with the environment (1976, pp. 34-35).

The truth Gattegno speaks of is the truth of experience, the experience of sensing and feeling the "mental-physiological" workings of our body systems as we apprehend or appropriate the objects of our environment, including ourselves. This ability, of which we have not learned to be conscious, is possible because of the intuitive capacity of the brain to seek and establish relations among the various levels of our experience.

If we are to become conscious of this capacity, as this paper suggests is possible, we need to identify ways to notice what is going on at levels we aren't used to attending to. To know introspectively or subjectively what is happening at various levels as we think and act we can make use of our five senses, in particular
that of feeling, and we can make use of our capacity for imagery.

We will consider examples of both methods.

**Being Conscious of Physical Changes**

As mentioned earlier it has been possible for some time to measure through electroencephalogram (EEG) the changes in rhythm of electrical impulses in the brain. Experiments where subjects have attempted to control these rhythms through conscious processes indicate both that it is possible (Nowlis and Kamiya, 1970; Wallace and Benson, 1972) but also that changes in these rhythms are accompanied by physical changes which are discernable such as the rate of respiration and slowing of the heartbeat (Wallace and Benson, p. 266). ¹

In studies of intuitive processes, researchers have attempted to identify detectable physical signals which accompany these processes. It was found in a problem solving activity with college students that heart rate increased sharply at three identifiable stages in the activity. However, when asked, problem solvers did not report they had been aware of these changes (Westcott, 1968, p. 93). Presumably, according to the premise of this paper, they could have been aware of these changes, since changes in heart rate are knowable to us directly.

**Emotion**

To understand how we can know more about our psychological selves by paying attention to such things as heart rate and respiration some researchers on intuitive processes have sought links be-
tween emotion and the way information is categorized and stored in our consciousness (Bastick, 1982, p. 216). One theory proposes that information may be stored according to certain "emotional sets" indicating that we were in a particular emotional state when the information was taken in and that it might be recalled quickly if that emotional state were re-experienced (Bastick, p. 217).

Bastick proposes that by paying attention to the "...multitude of physiological dimensions that constitute our feelings" we can be better in touch with these emotional sets, of which feelings are a part (p. 263). Research shows that the limbic area of the brain (please see Figure 4a) which houses the major endocrine glands (hence is a center of hormone production) functions in maintaining homeostasis or the 'constancy of the internal environment' for the whole human system. This region (the hypothalamus in particular) also plays a role in generating the combined physical-mental states we refer to as emotion (Rose, 1976; Bastick, 1982).

A Physiological Base for Self-Consciousness

The complex interaction of these systems is characterized by what are called feedback mechanisms which help to maintain homeostatic conditions in the body/mind. Recently, Karl Pribram has proposed that a similar type of mechanism, but called "feedforward", can be considered to be responsible for our capacity to attend to these internal events and to be self-conscious. He differentiates between "perceptual" consciousness, our normal daily state which I have called the illusory function, and "self-consciousness" which
allows our voluntary "intentional" control over capacities for attending and acting (Pribram, 1980, pp. 50-51).

I cannot leave this section without mention of my favorite of all anatomical friends of consciousness - the hippocampus. The hippocampus (also a part of the limbic area and so-named because someone thought it resembled a seahorse), is considered to be central to information processing and storage, but especially for new information. It has a variety of kinds of cells which can "count and remember," others which are "novelty-recording cells" and which fire only in response to a new stimulus (Rose, 1976, p. 242; Miller, 1981). Further, the hippocampus is credited with the capacity to retain spatial "maps" and to represent spatial meaning for us (Miller, 1981).

Perhaps most important, Miller sees the hippocampus as the central anatomical organ underlying intuitive capacity. It is connected with widespread areas of the neocortex (higher levels) of the brain, which allows it to "sample all neocortical activity and thus come under the influence of all inputs to the neocortex" (1981, p. 151). Because of the particular type of activity or plasticity of its neurons described above, a "multidimensional space" or "omni-connected network" is available to us for forming multiple associations from our knowledge store (p. 192).

Becoming aware of the messages our physical being may have for us is not a new endeavor but neither is it widespread. To allow these messages or feelings to come through to consciousness
could help, some believe, to increase the alternatives which present us in everyday life. Eugene Gendlin refers to this as "bodily awareness" or a "felt sense" which is a physical experience that can be known to our conscious mind (Gendlin, 1978). We have looked at the possibility of becoming aware of useful information by attending to direct sensory information and how we feel. We now examine our capacity for imagery.

**Self-Consciousness Through Imagery**

In the previous chapter we looked carefully at how information is stored in consciousness, suggesting that the holographic model seems closest to an explanation for our wholistic intuitive critical capacity. Healthy brains all possess this "omniconnected" capacity of which Miller speaks. What is not common to all of us is the ability to retrieve information from this store that can help us to learn, and live, better. Roberto Assagioli, an Italian psychiatrist and creator of a psychoanalytic method called "psychosynthesis", has suggested that intuition is a function of consciousness which has been repressed by what he calls the "contents of consciousness" - sensations, drives, emotions. These contents of consciousness are what cause us difficulty in becoming self-conscious (1973, p. 11).

**Limits to Self-Consciousness: Perception, Emotion, Values and Attitudes**

We have already considered, in fact, some examples of this type which are an important part of the illusory function of con-
sciousness but which inhibit critical consciousness. In Chapter III, we considered how the process of perception, based as it is upon past experience and our limited physical capacity, causes us to see what we expect to see. In spite of the opportunity we have for "choosing" this choosing can be limited by the contents of our consciousness which may cause us to pre-judge a situation or a person without seeking new information. The ambiguous figure demonstrated the difficulty in really seeing what is unexpected.

We have also looked at how emotion is linked with the categorization of information and the limits this may place on retrieving that information without the accompanying emotional state. We also considered the complex possibility of being aware of a number of "feelings" which might combine to create an emotional state but which sometimes themselves overpower consciousness so that awareness of the emotion is not clear.

Much earlier in the paper we considered a type of value or attitude formation resulting from what Freire calls a limit-situation - where unjust treatment of a group by another is seen or valued as appropriate because of inability to see the complete picture. Donald Streets and Daniel Jordan have defined values as relatively enduring organizations or complexes of information blended with psychomotor, affective, perceptual, cognitive, and volitional processes that predispose particular responses (1973, p. 303). Values, and their component attitudes, are directly responsible for judgments and actions we take.
In each of these three examples it is possible to see that much of what prevents us from being self-conscious in each case is that information or processes involved are largely unconscious. Some have described the totality of our thought and behavior as "biocognitive mechanisms" or structures, proposing that over time, "...habitual modes of perceiving and acting...develop" so that we become unconscious of these biocognitive structures (Davidson & Davidson, 1980, p. 40). The challenge is to become conscious of these structures as a form of insight which helps us to see that our style of information processing and retrieval (our style of behavior and thought) are "simply one way in which reality may be apprehended..." (Davidson & Davidson, p. 41).

Intuitive Retrieval

This paper proposes that one way to accomplish self-consciousness is to attempt to uncover the pathways which have caused our responses to become habitual. That is, we need to learn new forms of retrieving information from the vast distributed store so that old habits can be changed and new ways of seeing things be possible. There is much to suggest that this type of retrieval is not easy to accomplish. In describing the feedforward system which he believes allows us to be aware of our behavior, Pribram says that these mechanisms or "communications...take effort because they involve the reorganization(s) of the structure of neural information processing systems" (1980, p. 54).
It is even a lament among neuroscientists that very little research has been done on retrieval as compared with storage, very possibly because it is a "more difficult problem" (Rosenzweig, 1976, p. 596). We have all been frustrated with deliberate efforts at recalling information either for exact recall or for ideational purposes and ending up with a "blank." Eccles refers to retrieval on demand as "the most bothersome problem about memory." It requires, he suggests, the initiation of some neural input to "trigger" the replay of information (1973, p. 187) or a new synthesis.³

Assagioli is representative of those who believe that cutting through the unhelpful "contents of consciousness" can be best accomplished by retrieving information from the store (either as it went in or in synthesized form) through the use of imagery. He has constructed various activities requiring the formation of images to help illuminate psychological problems. These exercises are also useful in day-to-day activities or individuals who wish to become more self-conscious about their thought and action. An example of such an activity is included in the Appendix, entitled "As If". Detailed reports exist of the role of imagery in dealing with emotional problems, in particular, anxiety and fear (Lang, Gregory, Miller and Levin, 1980, pp. 123-151).

What seems to be known about this type of retrieval is that it requires a "receptive mode" oriented toward receiving information from the internal environment rather than manipulating it as we commonly but unconsciously do (Deikman, 1968, p. 325). In addi-
tion, this type of retrieval emphasizes reflective behavior but in a fairly nondirective way, i.e., searching the store but not rejecting what comes up or looking for something else.

Skills for Intuitive Retrieval (Introspection)

In Chapter II we stated that to be self-conscious is to exercise the power to reflect on how we change and are changed by interaction with nature. To be self-conscious is to reflect on our action. Action is both internal and external. But we are concerned primarily with reflecting on the physical and psychological changes which occur within us when we experience or act in daily life. We have demonstrated the possibility of psychological awareness of physiological change through attending to signals we might otherwise not notice such as heart and respiration rates and feelings which accompany emotional states. We have also indicated how imagery can be used as a form of retrieval to become aware of stored experience that otherwise remains unconscious.

Underlying all of these reflective efforts is the purpose of recognizing our ability to choose how we feel, what we perceive, what our attitudes and values will be, and to what stimuli we will respond. Chapter III has demonstrated that we do choose, whether consciously or not. Our purpose in training intuition is to be aware or self-conscious about this choosing. In this interpretation, being self-conscious about how we choose implies awareness of our access to the totality of consciousness, possibly to the entire distributed store of knowledge we acquire as each moment passes. In this way
we know that we can develop the critical wholistic intuitive function of consciousness.

Seeing the whole implies that our reflective capacity is also a monitoring capacity. The skills described here are monitoring functions which assist in retrieval. Although the words used to describe them are similar to those describing skills in "regular" learning or management activities, they are here seen to operate internally and for individual introspective use following the "endogenous" monitoring system proposed by Routtenberg (1980, p. 115). The skills described are gathered into three "skill areas": attending, question-posing, and evaluating. For each skill area suggestions are offered for recognizing the skill and for commanding it. Guide questions rather than suggestions are proposed for incorporating the skill into curriculum, since each learning group is different.

Attending

Attending means what you might think - paying attention to something. It can also mean absorbing, concentrating. When you are attending your brain is in a receptive state - you are receiving information and you are paying conscious attention to it. That is, your brain is always receiving information. You usually only attend to part of what is being received; sometimes you attend to none of what is being received; rarely and probably never could you attend to all of what is being received.

So attending means focusing on or paying attention to, or consciously receiving a particular 'bit' of information. Attending also
implies physical activity on your part. In order to receive information your senses are needed: you hear, see, smell, touch, taste or otherwise sense a form of energy or matter. Your senses are the receptors for the impulse that will eventually become the message to your brain. Attending is a way of monitoring and improving perception.

Neurobiologically the function of attention is attributed in part to a concentrated formation of neurons in the brain stem called the reticular formation (Rose, 1976, p. 296).

How Does it Feel?

What does it 'feel' like when we are attending - what are the signals we recognize that can tell us whether we are focusing on the 'right' thing at the 'right' moment or not? Think of a specific situation, for example, the classroom. Ask yourself, am I paying attention to what's being said or am I paying more attention to something else? What does it feel like to pay attention in class?

- All senses are focused on the same thing.
- You feel alert, active, 'absorbent'.
- You are directing your mind, choosing for it to be directed by the classroom activity.
- Non-essentials are being filtered out (noise outside, noise in the hall, your other concerns).
- Your mind feels 'engaged', invigorated, like your body does when exercising.

Looking at the opposite condition often helps to identify even more clearly how it feels to attend. You might ask, what are the signals I get when I'm not paying attention to the task at hand?

- You 'daydream', your mind wanders to other thoughts.
- You feel distracted.
- You sleep.
How Do I Command the Skills of Attending?

- Give yourself an order. Speaking out loud quietly to yourself may help.
- Control your environment. Ask for quiet, for open windows, etc.
- Adjust to your environment. Make up your mind to ignore distractions.
- Use a method or reminder. Associate looking at your watch with coming back to attention.

How to Incorporate Attending into Curriculum

Guide questions:

- What atmosphere promotes attending?
- How to get attention and keep it engaged?
- How to encourage learners to 'get' and maintain their own attention to the subject?
- Identify indicators telling me learners' attention is held?

Evaluating

Evaluating encompasses reflecting and choosing. Some easy examples are when you decide what to wear or what to make for supper or when to cross the street. In the classroom or a learning situation evaluating most often takes place not on a conscious level (except when learners are asked to evaluate a session). At the not-conscious level, however, information is evaluated constantly and categorized by the brain.

One of the purposes of an empowering curriculum is to become more conscious of this evaluating process. By being aware of how material is categorized by our brains, we become more aware of values and attitudes and what might need adjustment. That is, we become more critical of our own mental categories (and the actions they may direct us in).
Neurobiologically evaluating involves a comparison system very possibly dependent on comparator cells which are able to "memorize" an impulse and compare it to those received in the past (Rose, 1976, p. 133).

How Does it Feel?

What are the signals that tell us we are evaluating? Take getting dressed as an example. What does it involve? Reviewing what you have in your closet, thinking ahead to what you'll be doing, considering the weather. Now get back inside yourself. How does it feel to be pondering these ideas?

- You are searching for information.
- You are imagining your day.
- Weighing options for comfort, appearance.
- Being analytical.
- Choosing, or preparing to choose.

Now take the example of crossing the street. You'd look both ways, estimate the speed and distance of oncoming cars, judge when you have the best chance of crossing, and take a risk by doing so.

We can add to the above list:

- Estimating.
- Judging.
- Taking a risk.

Looking at the opposite, is it possible to know when you are not evaluating when you could be? For example, do you ever take action or make a decision when it doesn't feel quite right? Crossing the road when you "know" you shouldn't; spending money when you're not sure how much you have; listening to someone else's ideas and not allowing yourself to consider them at all? What does this feel like?
- You are stopping thoughts.
- Closing your mind.
- Switching to a different topic (not attending).
- Anger, anxiety, frustration.
- Choosing to act on impulse.
- Standing firm on your ground.

How Do I Command the Skills of Evaluating?

- Be aware ahead of time that you'll want to use this function when you normally might not.

- Be aware that you need to check values and attitudes regularly as you move from one person or group to another during the day or from one situation to another with the same people.

- Have a series of questions to ask yourself in recurrent situations to learn to evaluate automatically.

- Be aware that this function helps you check emotional responses.

- Make evaluating part of decision making and action.

How to Incorporate Evaluating into Curriculum

Guide questions:

- What atmosphere promotes evaluating? - Relaxed, trusting.
- How do I need to explain evaluating to this group to get rid of the idea that it means 'being tested' or examined?
- How to include it early and make sure evaluation happens regularly in learners' minds and in daily activities?
- How to make it simple and not distracting?
- How to encourage group evaluation?
- What evaluation methods can be repeated; when are new ones needed and to be created by whom?

Question Posing

Questioning is a fascinating skill area, perhaps the least understood. The use of interrogative words sets up a temporary void which the brain strives to fill with information as it searches for an appropriate response. Questioning is a creative function. But...
where do questions come from? Somehow a stimulus causes the searching of categories for the creation of a question and this, in turn, can set up mechanisms for retrieving material from new parts of the store or in new combinations.

Neurobiologically, the presence of the question mode or state of mind might be related to the feedforward mechanism which is believed to promote readiness and intentional behavior.

**How Does it Feel?**

- Alert.
- Fast moving.
- Passing over certain ideas and focusing on selected ones.
- Experimenting with interrogative words like "why", "what", "how" until we get the one that seems right.

And how does it feel when you can't get the question out?

- Blank.
- Confusing.
- Run-on thoughts.

**How Do I Command the Skills of Question Posing?**

- Plan ahead. Before an interview, class, appointment, dream, think what questions you have before receiving information or communicating at all. Do a dry-run of the meeting if someone else is involved.
- Attend critically rather than attending receptively. Leave your mind open for questions at the same time you are receiving.

**How to Incorporate Question Posing into Curriculum**

Guide questions:

- How to encourage critical attending?
- How to encourage critical reading, writing?
- How to encourage attention to where and when questions come to mind and where and when they don't come to mind?
- How to encourage learners to pose own questions around which to design curriculum?
Considering these skill areas when designing curriculum may yield learning experiences which enhance the critical consciousness of the learner. Some learning activities which have demonstrated usefulness in developing self-conscious awareness are contained in the Appendix as examples. The purpose of the activities is to provide access through nontraditional pathways to the workings of consciousness. They are ways of knowing which recognize a larger potential for sensory awareness of conscious experience. The final activity is a composite of techniques in Self-Evaluation which I believe are an essential part of the experiential learning cycle.

Subjective Knowing

This paper began by looking at some of the ideological oppositions which have accompanied the growth of knowledge in our culture. One of the main points of contention has been by what means the individual acquires knowledge which can be proven, believed, considered truth, if you will. Evidence was presented, however, that the positivist approach, which has held sway for some decades, may need some adjusting; the need identified in part from 'new' knowledge in the realm of physics and in part from the evidence of social inadequacies of the present day.

But what does this adjustment entail? Those engaged in the formal acquisition of knowledge through scientific investigation are asked to now consider themselves part of their experiments, to take into account both the physical and mental effects they bring to the endeavor. Those of us engaged more often in the nonformal acquisi-
tion of personal knowledge from day to day are asked to be aware of ourselves as conscious agents in our daily acts. For this type of adjustment, the use of subjective methods of knowing will need to combine with those objective forms which we now, for the most part, employ.

In discussion on the creative process, psychoanalyst Margaret Brenman-Gibson expresses a view she finds growing among 'social' and 'natural' scientists alike:

The essential point I want to make here is that in this, our twentieth century, these two approaches to knowledge are rapidly converging even within the scientific establishment, and that the time is overdue for good minds in the West consistently to apply the subjective as well as the objective method of gaining knowledge (Brenman-Gibson, 1973, p. 327).

Valuing subjective experience is central to the field of psychological therapy and to artistic creativity. But for most of us, paying attention to what does on "inside" of us - beyond the regular things which we must pay attention to like hunger, fatigue, overt anger - is not a familiar task. But in developing critical consciousness, in becoming subjects who know and act (Freire p. 20), trusting our experience of the activity of our consciousness is a task, at least to be practiced if not mastered. We need to accept the primary definition of subjective as quoted in Chapter II and learn to trust our experience of "...the real nature of things..." The delineation of the skill areas above may help to simplify the task of acquiring knowledge through introspection. For although introspection may be a "fickle source" (Miller, 1981, p. 198) when seeking agreement with others it is unavoidably relevant for self-conscious development.
**Educational Settings**

We have said that training our intuitive capacity requires attention to feelings, emotion, our internal private selves. In addition, it requires the use of imagery. Studies have shown that use of intuition involves a tolerance for ambiguity and a significant amount of risk-taking (Westcott, 1968, p. 94-5). This implies the need for a learning environment free from threat and the fear which can result from a threatening atmosphere. Even though our intuitive capacity is primarily a function of the upper hemispheres or the neocortex it can still be affected by the so-called reptilian and limbic systems which regulate emotion, hence, fear. In a situation which inspires fear these systems can overpower the intuitive function, paralyzing it in a sense, causing the learner to withdraw or "flee" from the situation, rather than learning. Leslie Hart, in his book entitled *Human Brain and Human Learning*, has stressed the need for nonthreatening "ambiance" in the learning environment (1983, p. 133). What kind of educational setting can create this environment?

In Chapter I, we stated that the experiential learning cycle most closely expressed the relationship between experience and learning which supports this study. To go further, however, two more components are necessary to complete a learning environment which contributes directly to the development of the critical function of consciousness. They are the participatory and empowering models. The participatory model is based on an atmosphere of re-
spect; learning content has immediacy for people's daily lives; all learners share in the leadership of the group; and much of the learning is derived from learners' experience (both from the past and during learning activities).

The empowerment model (Kindervatter, 1979) adds to these two groups or characteristics the focus on small group interaction; content which stresses self-reliance; a design which includes transferring responsibility for the learning program to the learners; a non-hierarchical structure; and content which is directed toward improving learner's economic, social and political standing (Kindervatter, p. 150-152).

This combination of characteristics provides a framework (please see Figure 11) within which learners can feel free to seek and discover the illusory aspects of their lives and society and to create, when necessary, totally new alternatives for liberation.

**Summary**

In this chapter we have looked at the physiological base of learning known as plasticity and the accompanying physical and psychological signals which are all a part of learning. We have examined the possible explanation of our self-conscious capacity at the physiological level in the special nerve cells of the hippocampus and their multiconnectedness with the neocortex. This capacity was linked to our ability to create images. Imagery was then considered as a "new" form of retrieving information from the whole of consciousness by training ourselves to overcome certain limits to self-consciousness such as perception and emotion.
Figure 11: Educational Framework for Developing Critical Consciousness
Three skill areas were outlined which can help us to make use of this capacity for a "new" form of retrieval: attending, evaluating, and question posing. These skill areas were described as helpful for developing introspection and as a means for subjective knowing. Activities demonstrating the use of these skills are described in the Appendix.

Finally, a framework was defined describing critical consciousness as transformation and reflection. The framework illustrates how self-consciousness, through reflective practice, monitoring skills, and program design can give us access to our intuitive, critical capacity for self-conscious choice. The components of this framework include not only the skill areas defined but the innate mechanisms of imagery and feeling which can be employed to have greater access to consciousness. The framework also includes the essential components of content stressing self-reliance and economic, social and political justice as well as a structure which is participatory. This combination of components creates a framework for the development of critical consciousness.
NOTES

1. More recent experiments with alpha feedback training have tended to negate or at least qualify some of Nowalis and Kamiya's earlier results. However the demonstration that it is possible to affect alpha rhythms is not questioned. Rather "uniform subjective experiences" are unlikely to emerge from present research methods. Orne, Martin T. and Wilson, Stuart K., "On the Nature of Alpha Feedback Training," in Davidson and Davidson, The Psychobiology of Consciousness, (NY: Plenum Press, 1980) pp. 359-400.

2. The limbic system or area of the brain, containing the hippocampus and several other structures, is concerned most extensively with homeostatic regulatory systems and with emotion and motivation. Rose, Steven, The Conscious Brain, (NY: Vintage Books, 1976) p. 277.

3. The hippocampus is believed to play an important role in retrieval (Eccles, 1973; Routtenberg, 1980; and Miller, 1981). The proposed ability of the hippocampus to represent global contexts and spatiotemporal patterns is again considered significant. Miller, Robert, Meaning and Purpose in the Intact Brain, (Oxford: Clarendon Press, 1981) pp. 185-6.
CHAPTER V

CONCLUSION

This paper has attempted to bring a clearer understanding to teachers and learners of that part of ourselves we are so intent upon affecting. Whenever a new approach to teaching and learning is presented there is often an implication that no one has been able, really, to teach or learn properly before its presentation. That is not the implication of this study. We all learn, in many ways, all the time; if we consider learning at the level of the synapse, there is really no way to stop one's learning. And as all of us know who remember our best teachers, it is difficult to stop a good teacher from helping you learn.

The significance of this view of intuition as one level of an open, dissipative system which is capable of achieving continual change without complete destruction of itself is that those teachers who have always known how to help others learn but were not sure how they did it can begin to understand this creative process. In her book Teacher, Sylvia Ashton-Warner graphically describes her own intuitive process of helping children along the path to discovery and self-consciousness. She relied on the natural ability and inclination of her young students to question, test hypotheses, reflect on the results and try again. She gave them the opportunity to put into their own framework the pieces of information and the actual experiences she knew they would somehow, sometime need (Ashton-Warner, 1963).
This "open system" framework for consciousness and the role of intuition in learning can also help learners themselves to make better use of their own capacities. Although we are each a different combination of matter, energy, and ability, the physiological and psychological systems described here are something each of us can rely on as a base from which to begin. Even when brain mechanisms are damaged by accident or illness their remarkable ability to recreate learning and acting capacities has been documented both in the physical sciences and in psychoanalysis (Luria, 1973; Assagioli, 1973).

Making use of these basic capacities is an innate operation which, as we have said, is very difficult to prevent. The challenge as the paper suggests, is to develop those aspects of our conscious capacity which require self-conscious attention. Some have suggested that the need for the development of intuition and a wholistic capacity of consciousness is part of a movement which is traceable through history but which has, until now, not received serious attention from enough sources (Ferguson, 1980). Whether, indeed, we are at the dawn of the Aquarian Age will have to be determined elsewhere. What seems clear from developments in physics and the neurosciences and the coming together across formerly fairly rigid disciplinary boundaries of scientists and educators is a new call for education to address itself to the need for self-consciousness in learning.
To become aware of our own learning processes, to intervene to change behavior, actions, even perception, is what is implied by this call. At the same time, this kind of awareness may have a difficult, perhaps even frightening prospect. Being able to perceive reality at more than one level in the physical sense has in the past been left to those engaged in transcendental meditation and hallucinogenic excursions. Taken to their limit some of the ideas in this paper imply that each of us is able to perceive reality at many levels. For example (using "left" and "right" brain distinctions for simplicity) what if the traditional division between materialist and idealist views comes from the left brain, right brain tendencies (respectively) -- always vying with each other but not quite in unity. Hence the "left" brain is concerned with the material, the concrete, what can be "proven" objectively and observed through our senses. The "right" brain constructs wholistic pictures and is concerned with the aesthetic, the intangible. But enter the paradox. The "right" brain is the one that is capable of discerning the concrete directly. And the "concrete," the reality, is, of course, waves, particles, relationships, change, the dissipation (constant use) of energy. On the other hand, it is the "left" brain's task to translate this quantum reality into the daily illusory reality (though we view it as concrete). And for some reason (to avoid confusion, to avoid giving us too many choices?) the "right" brain does not make its information directly known to us, but slips it by our daily consciousness and into "lefty's" grasp.
Whether or not the age-old materialist/idealist debate is connected to these complementary brain functions, the fact remains that other levels of reality than those we "see" each day do exist. The "house of cards" that is our daily illusory reality may be more than nudged as we continue to learn more about other realities from physics, chemistry, biology. Being open to information from these fields is crucial for educators. In 1971, Jerome Bruner recommended that we pay more attention to what physics can teach us about the "observed surface" (our illusory reality) and the "structure of regularity" (quantum reality) underneath it. He wrote:

Physics is not so much a topic as a mode of thought, (it is) an apparatus for processing knowledge about nature (rather) than a collection of facts... (it can help us learn to) process unrelated things... (it is) a constant exercise in problem solving (p. 109).

Indeed, perhaps physics can help us to see how our own consciousness is capable of processing "unrelated" things. One of the significant aspects of physics (and most science) is its system for measuring what is going on. Why do we need to measure? To pinpoint things in time and space; to attach numbers to the object of observation so that we can discuss and communicate about it and compare and contrast these data with other data. Measurement is a necessary part of our being able to communicate about something. Measuring translates something intangible into a symbol system (mathematics) which allows us to discuss the events we are observing in the abstract. Discussion is abstracting (pulling away from the concrete).
This process of measuring and symbolizing is part of the transformation which our brains accomplish (recall Einstein, Poincaré) when we transform events into language (and theory). Take the example from above where our "left" or illusory function has the task of presenting the quantum reality to us as daily trees and flowers. The "right" or critical function has already taken in this information and it becomes transformed, perhaps through some cooperative activity of both functions. This process bears a resemblance to the "measurement" which occurs in quantum mechanical experiments:

The point to think about is that when we make a measurement in a quantum mechanical experiment - when the observed system (remember the photon?) interacts with the observing system (us) - we reduce a multidimensional reality to a three-dimensional reality compatible with our experience (Zukav, 1979, p. 76).

The quantum reality of waves and particles (the observed system) comes in contact with our consciousness (the observing system) and is transformed into a reality compatible with our experience.

Choosing our Reality - Stabilizing the Cards

And, one may well ask, won't this knowledge of many possible realities be more confusing than it is helpful? It may well be more confusing than helpful unless we develop our capacity for choosing which reality we want to live in. The significance of the capacity of consciousness for choosing realities becomes clear at the social action level. Being able to perceive more than one level of reality at the social level can lead to dramatic changes in political and sometimes social structures. But since we all choose all the time, how do we consciously choose the "best" reality? There is no guarantee.
But some social scientists are joining themselves with Prigogine and others from the natural sciences in exploring what positive social effects can evolve for humanity from the "evolutionary vision" mentioned in Chapter II.

Boulding has done what she calls "life span" studies on individuals to ascertain how their consciousness develops regarding how they "image" or "vision" the future. She categorizes people according to the following modes:

1. Essence optimism combined with influence optimism: "The world is good and humans can make it even better."

2. Essence optimism combined with influence pessimism: "The world is good, but it goes of itself and humans cannot alter the course of events."

3. Essence pessimism combined with influence optimism: "The world is bad, but humans can make it better."


Responses seem to indicate that a "self-organizing" principle is operative in individual consciousness so that at some stage in the lives of those interviewed both over-optimistic and over-pessimistic world views become modified based not just on experience in the world but also on the "evolutionary vision" from within. In his summary of Boulding's work, Jantsch describes this period as the time when "knowledge blends with wisdom" and when "evolutionary visions appear as the structures emerging from the self-organization processes in the human mind" (1981, p. 11).
Boulding describes her own work as beginning bridging the gap between the knowledge of evolutionary processes in the physical and biological sciences and the knowledge of human development in the social sciences. She is cautious yet hopeful about our capacity for choosing the "best" reality:

It is sobering to realize that the insights concerning human betterment available to us have been extant more or less from the beginning of recorded history, and that relatively little progress has been made, if any, in choosing the good on a societal level. It is true that compared to other evolutionary timespans, the timespan of recorded history is short...the evidence from the exploratory study described here is that an appreciation of (the tempo of growth in human wisdom) is precisely what comes in the later years of an individual's life. We may, after all, be on the threshold of significant conscious contributions to the socio-cultural dimensions of the evolutionary process (Boulding, 1981, p. 192).

The evolutionary vision which stems from discoveries in modern thermodynamics seems to me to be directly related to the development of a self-conscious social system which both implies and requires the development of our critical consciousness as individuals in society. The development of this wholistic critical function which improves our capacity for choosing implies both new directions in education and a new perspective on social change. Our role as teachers is to grasp the significance of the levels of our reality and their connections and to help learners do the same. Ira Shor, in his book, Critical Teaching and Everyday Life, puts it this way:

I can't imagine a more optimistic way to go about education. The grand conception of teaching as preparing students for their history-making roles defines our work as the restoration of our full humanity (1980, p. 269).
The "new direction" in education is to point out to learners their role as history makers. The new perspective on social change is to borrow from the self-organizing structures of thermodynamics the concept that growth and development are possible without abusing people physically and mentally and without destroying the earth's environment.

This excursion into consciousness may bring our intuitive capacity out from its mystical hiding place while at the same time just opening the door a tiny bit to the possibilities which lie within the brain. Without doubt those mysteries can challenge us to greater discovery. For now, however, what we can glean from this excursion reveals a responsibility to address the social and political structures which, without self-consciousness, continue to create oppression. If, as Freire says, domination has been the theme of our epoch, liberation through critical consciousness is the theme of education.
BIBLIOGRAPHY


Pribram, Karl H., "Modes of Central Processing in Human Learning and Remembering," in Brain and Learning, pp. 147-163. op. cit.


Vella, Jane Kathryn, Learning to Listen, Amherst: Center for International Education; University of Massachusetts, 1979.


APPENDIX
Shedding Light on the Subject

One way in which quantum mechanics is often explained is by describing experiments that involve photons, or quanta of light. The question of what the real nature of light is has fascinated scientists for a long time. Light is that part of the electromagnetic spectrum which is visible to the human eye. The electromagnetic spectrum (please see Figure 7) includes all the types of energy or "rays" that we know about, for example, x-rays, infra-red light, radar, sound. It has long been understood that these forms of radiation or energy behave with the characteristics of waves. It is possible to measure the frequency and amplitude of light waves just as it is of ocean waves.

The confusing, and eventually revealing, thing about light (and other forms of electromagnetic energy) is that in addition to acting like a wave, it also behaves as if it were composed of particles, photons as Einstein called them, or "quanta" in the words of Max Planck. The fact that light demonstrates wave-like properties of diffraction and interference seemed not to be possible if it also behaved like particles, as in the "photoelectric effect" when a beam of light is directed at a metal plate and the plate ejects a shower of electrons indicating that the photons were hitting electrons with an individual, billiard ball-type effect (Barnett, 1948, p. 25).

In 1925 Louis de Broglie demonstrated that electrons, which were understood for a long time to be hard spherical particles, could also behave like waves. Schrodinger developed a mathematical
method for explaining the "wave functions" of these particles of matter (which we commonly know as electrons, protons, atoms and molecules) (Barnett, p. 29). Thus Einstein's theoretical demonstration that energy and matter are different forms of the same thing continued to be proven as wave-like energy (light) behaved like particles and particle-like matter (electrons) behaved like waves of energy.

In these demonstrations scientists were observing phenomena which their paradigms or belief structures could not explain or would discount as false. But in the continual search for explanations eventually and gradually new paradigms are built which accommodate what was formerly inexplicable. Thus Schrodinger, Bohr and Heisenberg, among others, contributed to a mathematical explanation involving "waves of probability" which could be used to predict the behavior of these confusing particle/waves of energy and matter.

Probability and Perception

If we look again at the situation illustrating Heisenberg's Uncertainty Principle where the limitations of our own visual apparatus prevent us from measuring both the speed and position of an electron without disturbing one or the other with a beam of energy, these waves of probability come in handy. They allow the observer to at least predict the speed or position of the electron within some range of probability acceptable to other scientists as valid experimental evidence. Thus it becomes possible to record systematically these "observations" of subatomic phenomena.
This type of probability is, however, somewhat different from the regular idea of probability -- the prediction of a likely event in the future. This type of probability refers instead to something that is actually happening but at a level at which we are not necessarily able to apprehend it. Zukav refers to such probable happenings as "tendencies to happen" with probability waves being catalogues of these tendencies (1979, p. 66). To demonstrate these tendencies he describes the experiment used to show that a "particle" of light, a photon, has both wave-like qualities and particle qualities.

In this experiment, the photon is beamed at an upright surface with two slits in it side-by-side. When one slit is covered the light reaches the wall behind the surface and forms an uninterrupted circle of light. When light travels through both slits, however, instead of a wider circle of light on the back wall, what appears is a series of alternating light and dark vertical strips which are a wave-like or interference pattern found in water and sound waves as well. The question which quantum physicists try to answer in this case is how does the photon "know" whether to behave like a particle or like a wave? That is, if only one slit is open, the photon apparently travels through it and forms a particle-like circle of light on the wall. But when both slits are open, this single photon can travel through both slits at once to form an interference pattern on the wall.

One version of the waves of probability theory answers this dilemma by proposing that at any one time there are an infinite num-
ber of probable ways in which the photon could behave and that what causes the "actualizing" of one of those probabilities is our own observation of that event. Zukav states it this way:

In a quantum mechanical experiment, the observed system, (the photon in this case) travelling undisturbed between the region of preparation (the light source) and the region of measurement (the wall), develops according to the Schrodinger wave equation. During this time, all of the allowed things that could happen to it unfold as a developing wave function. However, as soon as it (the photon) interacts with a measuring device (the observing system or us) one of those possibilities actualizes and the rest cease to exist. The quantum leap is from a multifaceted potentiality to a single actuality (1979, p. 75).

This view implies that by an act of perception we "choose" that one of a number of possible events which will actualize or happen. What physicists seem to be saying is that we are inextricably related to the matter which we manipulate during experiments. We cannot view them as an activity outside our personal influence. We are part of the activity. The results of the experiment are a result of the action of our consciousness upon the "system" of the experiment itself. We are involved personally, subjectively, in the experiment.
Activity 1

"As If" *

You are asked to relax, clear your mind, and to imagine a situation in which you often find yourself (or expect soon to find yourself) when a strong emotion gets the better of you. Imagine the scene (for example an encounter with an authority figure) all the way through as it might happen, at its worst. Then imagine yourself and a characteristic you would like to have or a manner you wish to maintain throughout such an encounter. See yourself in every aspect; feel how you would want to feel; keep this image until it is very strong; practice recalling it. Then reconstruct the encounter, only this time with your new image. See it through to a preferred conclusion; try various alternatives. Relax again, dissolving all images.

Repetition of such exercises has helped individuals expand their capacity of change behavior in various situations.

Activity 2

"Seven Questions" *

Sit in a relaxed position, breathe quietly and clear the mind for receiving images. Using crayons and paper, draw the image you receive following each question. After each image is drawn you may write what it represents to you if you like.

1. Where am I now?
2. Where am I coming from?
3. What does change mean to me?
4. How would I like to be?
5. What's stopping me?
6. What do I need to get there?

* Adapted from psychosynthesis techniques.
Activity 3

"Sinbad" *

This activity is useful with people in groups who need to work closely together and who need to become aware of values they hold which may cause conflict in the group. This exercise helps point out that discovering values is an involved process.

The essence of the famous tale of Sinbad is that a young woman, in order to reach her betrothed who is across the raging river, agrees to make love to Sinbad, the operator of the only ferryboat to be found. The tale, involving other characters, can be read silently, or narrated and illustrated. Listeners are asked to rate each character in order from 'best to worst' and, depending on the objectives of facilitators and size of the group, may then be requested to integrate their rankings with others and come up with a consensus list. Discussion questions such as "who was worst and why?" or "what would you have done in so-and-so's place and why?" often lead people to state and defend a position they were not aware they held. Reflection for days following the exercise is also a significant part of becoming self-conscious about one's values.

* Adapted from Peace Corps training materials.
Activity 4 *

The Choice Point

Now we will examine a way of using introspection in a practical way. Imagine you are walking down a dark, empty street at night and you see a figure weaving uncertainly toward you. What goes through your mind? You probably attempt to make sense out of what you see, to categorize the figure based on your experience. Your categorization will also be influenced by the immediate environment (darkness, no other people). You may decide that this figure who cannot walk straight is drunk and therefore it is better for you to cross over to the other side of the street. You may do so, or you may continue to walk undecided until the person comes close enough for you to see more clearly who it is. You find, with some relief, it is an elderly person having some difficulty breathing who could use your assistance to reach his door some few feet away, and you provide that assistance.

The cycle of mental behavior we identified looked like this:

Observation → Perception → Judgment → Action

Choice 1  Choice 2

* Designed for crosscultural training, 1977, School for International Training, Brattleboro, Vermont. Special acknowledgment to Peter Falion.
In the example above, you observed the person coming toward you, your perceptive apparatus told you it was a person, not walking straight, hunched over. You then had the opportunity to make a judgment about how you would relate to this person and whether it would be wise to cross the street, that is what immediate action to take. Somewhere between the arrival of information into your conscious mind and the point at which you decided to continue walking toward this person, there was an opportunity for you to choose what judgment you would make about this person. A second opportunity for choice in this "mental behavior sequence" occurs following the judgment and before the action.

**Recognizing the Choice Point - Using a Reflective Sequence**

In Chapter II it was stated that as we experience through our senses, both physiological and psychological change occurs in consciousness. For example, in the dark street scenario just described the visual process itself produces chemical and electrical changes in the brain. It is proposed that at each point along the sequence, and especially at the choice points, there is not only change, but the potential for self-consciously intervening to "rearrange" not only physiological connections, but psychological categories. If you judged that the person was drunk based on your perception and crossed the street, normal changes would occur which accompany any action. However, if you judged the person was drunk and stayed around to find out you were mistaken, it is hypothesized that your perceptual categories would become altered. There-
after, perhaps, when viewing someone walking in a manner strange to you, the "he/she is drunk" hypothesis would be accompanied or superceded by "this person is having trouble walking."

Whether or not this new response occurs could depend on how often you find yourself in a similar situation. The occurrence of this new response will also depend on whether you consciously choose to exercise it. The key is to know that you can intervene in your own mental behavior in order to change it. This intervention required a reflective sequence of events which generally follows the pattern of questioning, reflecting, choosing and acting, however, like the experiential learning cycle, one might begin at any point and follow the sequence.

In order to teach ourselves and other people to become more self-conscious about their capacity for choosing to influence their own thought and behavior, the sequence provides a useful tool for describing the microlevel process of consciousness. Just as with any point on the experiential learning cycle, also at any point in the observation-perception-choice-action sequence it is possible to intervene to change behavior. First by questioning, "What is going on, what do I think I see, can I see it another way?"; then by reflecting on the possible answers to those questions; then by choosing to implement one of them; then by acting.
Activity 5 *

When looking at Figure 12 it is possible to see at least two different images, one of a lady with a hat and feather, another of a lady wearing a scarf. Usually only one image will be immediately perceptible to you. Once it is clear, then try to see the other. Then allow yourself to see one, then the other with less and less time in between. But attempt to pay attention to that "time" in between seeing one or the other image. Then simply look at the figure and be aware of when one or the other image comes clear to you. In this last case, observe which image is stronger for you without consciously choosing which to see. It is possible to imagine that in this activity your perceptual apparatus was "choosing" which image to see, based upon what you are used to seeing and how you make sense of what you see. Presumably, when you intervened to see one or the other image of your choice, this sequence was active and at a very rapid rate.

* Adapted for crosscultural training from figure/ground optical illusion by Boring.
Figure 12: Ladies
TECHNIQUES IN SELF-EVALUATION

Self-evaluation techniques for the learner to use 'alone.'

A. LEARNING CONTRACT - to design your own plan for learning something; to monitor your activities while learning; to create a product as evidence of your learning; to design criteria or standards to validate your learning (Knowles, Self-Directed Learning).

B. KEEPING A JOURNAL - to record factual events that affect you; to record how you felt about those events; to maintain a record for comparison in the future.

C. PEER COUNSELLING - to discuss with a friend or colleague on a regular basis your behavior and feelings toward a person, or in regard to a problem.

D. PERSONAL GOAL-SETTING - to write down your goals or expectations for the day, a week, a month, or for a particular event, and later compare your expectations with what really happened; to assess why your goals were or were not met.

E. SELF-DIAGNOSTIC PROCESS - to develop a model for a behavior or skill you desire to learn or improve; to assess your level of performance in this behavior; to assess what action you must take to move from your present level of performance to the desired level (Knowles, Self-Directed Learning).

Self-Evaluation techniques for the learner to use with a group.

A. FEEDBACK - to evaluate how you perceive others and how others perceive you; to share opinions about what is happening, why it is happening and how it might be different. Feedback can be written, spoken, or non-verbal (through body language).

B. INTERVENTION - interrupting a discussion, a meeting, a training session to resolve a conflict; to demonstrate a point about individual or group behavior.

C. ROLE PLAY, SIMULATION, CRITICAL INCIDENT - to observe how people interact with each other and to analyze why they behave the way they do. These activities are designed to allow the learner to question and reflect, judge, to choose, and to act as they would in 'real life.' Each activity is then processed or discussed so learners may try to identify the attitudes and values determining their behavior.

D. GROUP-DIRECTED ACTIVITY - to design and implement an evaluation activity, either spontaneously or with prior planning, in which each group member contributes something to the design. The activity is implemented by the group sharing leadership (that is, the trainer, staff supervisor, or facilitator does not intervene).

* Developed and used 9 February 1979 in Evaluation workshop with Indonesian Advanced Management Training Seminar.