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LEARNING AND PERFORMANCE: A CRITICAL INQUIRY

by

(C) DANIEL JAMES PEACOCKE

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(SIGNED) Dan Peacocke

PERMANENT ADDRESS:

13511 - 135 Street
Edmonton, Alberta
Canada, T5L 1Z3

DATED April 9, 1987

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled

submitted by DANIEL JAMES PEACOCKE in partial fulfillment of the requirements for the degree of MASTER OF ARTS in PHYSICAL EDUCATION.

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Supervisor

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Date ....

Dedication

As [illegible] expression of my gratitude I dedicate this thesis to my parents, Jim and Pat, and to may aunt, Muriel Peacocke.

Mom and Dad have always provided the encouragement and unconditional support needed in helping me reach my goals. Most importantly they have shown me how to blend the values of effort and discipline into a loving, caring environment.

From my aunt, Mimi, I've learned the real meanings of determination and committment. Her loving care of my Grandmother during her extended time of need was a sad yet wonderful inspiration to me. I hope that these qualities that I have learned from her, along with the positive values that my parents have instilled in me throughout my life, will stay with me and quide my continuing development.

ABSTRACT

This thesis outlines the developmental features that influence the progress of learning and performance. Much has been written about specific elements of these two areas. In fact, they have been *analyzed* so much that it is often quite difficult to see the "real world" practical applications contained within the ideas presented. Thus, in order to provide an enhanced visual picture of learning and performance situations, a *synthesis* approach is taken here, attempting to pull together the thoughts contained in many published and unpublished research reports on related subjects. A *holistic* ***model*** is presented along with the developmental framework that supports it, in hopes of illustrating more clearly the significance of this work.

Some of the most noteworthy ideas presented in the pages which follow reflect on notions of *knowledge acquisition* , on the significance of *conscious* ***and*** *subconscious* control processes, as well as on the critical influence of *context* . Further to this, an important distinction between situations of *learning* , *learning to perform* , and *performing* are discussed.

Based on the operation of the dynamic, integrative knowledge base system presented, the conceptualization of a *context control* program is discussed. This program may have positive implications for enhancing both learning and performing. It has particular relevance for sport specific mental skills training programs, and it also may provide valuable insights with regard to a much broader,

complete "education" package.

Essentially this thesis is a philosophical inquiry, that for the moment, provides a stable foundation upon which many future practical research studies in athletics and education may be based.

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INTRODUCTION

> No sensitive person can look at the sky on a cloudless night without asking himself where the stars came from, where they go and what keeps the universe in order. The same questions arise when we look at the internal universe within the human body or even just at that pair of sensitive and searching human eyes which constantly strive to bridge the gap between these two universes (Selye, 1956, p. 442).

Building bridges between internal (individual) worlds and external (environmental) worlds must be the ultimate aim of any study where the primary objective is to more completely understand how people learn and perform. But when one looks at the procedures that are commonly followed in arriving at this "building bridges" construct a strange paradox emerges. As Ostrander and Schroeder (1979) state "usually in our efforts to learn we've separated ourselves into pieces" (p. 5). The paradox is established in the comparative processes of analysis versus synthesis. How is it that in the scientific communities' attempts to *build* , a process of *breaking down* has become so pervasive? Clearly, the answer lies in the necessary search for more and more detailed information about the operation of our world. Toffler (1980) states that "the more diverse the civilization - the more differentiated its technology, energy, and people - the more information must flow between its constituent parts if the entirety is to hold together" (p. 167). Unfortunately, as Toffler goes on to state, the situation now is that "an information bomb is exploding in our midst" and for many "it is difficult to make sense of this swirling phantasmagoria" (pp. 156-158). In attempting to make sense of the vast amount of material that is now available on the topics of learning and performing one is often left with the feeling of being stuck in the middle of a huge library, surrounded by thousands of books and journals, without any form of cataloging or reference system. For the majority of people information organization skills (synthesis skills) simply haven't kept pace with the development of information generation and storage capacities. Smith (1975) commented more than ten years ago that "the present helter skelter generation of data in the academic disciplines reminds me of an enthusiastic ditch digger committed to digging as deep and as fast as he can. It works alright at first, but soon his shovel handle is too short and to make matters worse, most of what he throws out falls back" (p. 250). Debono (1967a) defined the problem even more clearly. "Many scientists and others believe that information is self organizing, that one only has to go on collecting information and eventually it will sort itself out into something useful. Even if this is true it is still an extremely wasteful and expensive process" (p. 15). The problem appears no less significant today.

The critical inquiry into the realms of learning and performance presented here is an attempt to pause, in the midst of the accelerating generation of new information, just long enough to develop a conceptual framework against which future experimentation and discoveries can be organized and evaluated. As Bruner (1983) suggests "knowing how something is put together is worth a thousand facts about it. It permits you to go beyond it" (p. 183). In the pages which follow the ideas of many researchers will be pulled together and fitted into one all-inclusive framework. This framework is not intended to be a fixed structure. It most assuredly will have to be modified as more knowledge is integrated in the future. It's value is that it is a structural starting place. "Learning, is most often, figuring out how to use what you already know in order to go beyond what you currently think. There are many ways of doing that. Some are more intuitive, others are formally derivational. But they all depend on knowing something structural about what you are contemplating" (Bruner, 1983, p. 183). The challenge at hand is to take the building blocks that are now available and build a structure that will allow interactions to be seen. For as Debono (1969) states, "it is not always easy to infer the over-all behavior of a system from a detailed examination of its parts. This is especially so when the parts themselves, rather than their relationships with each other, are studied" (p. 149). At first, the generation of more data regarding as many different components of learning and performance as can be distinguished seems logical and well founded "until one remembers that animal life is not merely a collection of biological systems, but that all life is singularly distinguished from the inanimate by an exquisitely harmonious communion among all functional parts, and by elaborate, unifying mutual interdependencies that produce an indivisible whole whose qualities transcend the physical elements of its parts" (Brown, 1980, p. 137). With this fact serving as a solid foundation the following discussion will attempt to deal with T. S. Eliot's question, "where is the wisdom we lost in knowledge? Where is the knowledge we lost in information" (Cousins, 1981, p. 26)? The expected result of this *synthesis* study is that by developing a conceptual framework of learning and performance, the **interactions** bet[illegible] of information will yield new knowledge. In turn, it ma[illegible] [illegible] be possible through **integration** of new knowledge to gen[illegible] some wisdom.

THE FOUNDATION

One outcome of this inquiry is that the role that *context* plays, in the development of environments most conducive to efficient and effective learning and performance, has become most significant. As such this section is intended to *set the scene* (establish an appropriate context) from which the following barrage of information, which has been extracted from a review of the literature, may be most effectively assimilated.

Brown (1980) states that "learning, meaning to benefit by experience, changes the reactive properties of neural tissue and is the agent that changes the chemical structure of genes and changes the messages that genes carry from generation to generation" (p. 48). In addition to this Wall, Bouffard, McClements, Findlay, and Taylor (1985) state, in reference to R.L. Holloway's work on human brain evolution, "through the process of human evolution, the brain has emerged as an organ uniquely suited for learning and development" (p. 28). If it is indeed true that human beings have a system "built for learning" and that the system changes itself through learning, then as Ostrander and Schroeder (1979) claim, "we need to learn how to learn" (p. 4) in order to guide our progress.

The ability to integrate knowledge; to "go beyond the information given" by building bridges (not just acquiring information); to take full advantage of both subconscious and conscious processing in the brain; to understand the significant role that context plays in guiding performance; and to view these functions as ever-changing, dynamic forces; are the fundamental requirements for "learning how to learn".

Contrary to Baars' (1983) statement that "there is little or no evidence that we can acquire new relationships between inputs without awareness" (p. 58), the world of biofeedback offers numerous examples that people do learn subconsciously. "Learning to control a single cell is no doubt the supreme example of the ability of the unconscious mind to absorb information, interpret perceptions, make association, evaluate meanings, decide the most parsimonious execution of its intentions, and finally set a selected activity in motion" (Brown, 1980, p. 267). The apparent conflict above (and others like it) results from experimentation that freezes the human being in action and looks at isolated instances. Human function, however, does not occur this way. There is a circular nature to human function which makes the search for starting and end points valuable only to the degree that they may occassionally provide a break in the circle allowing it to spiral upwards creating a new circle at a higher level. To understand how the process of spiraling upwards occurs, a developmental perspective seems most logical and a holistic model outlining potential pathways for development is required to make the process easier to follow.

Based on a synthesis of relevant information, such a holistic model will be presented. It develops from a framework of concepts that are discussed throughout the review of literature which follows. The reader may find it advantageous to refer back and forth to the model (figure 2) while reading through each section, in order to *see* some of the interaction effects. This may encourage the process of building and integrating, or consolidating, as opposed to the separating of ideas. Thus the limitations of a step by step written analysis of component parts imposed on the reader are minimized.

The advantages of presenting a model along with the conceptual framework that supports it are three fold. First, it may help in maintaining some simplicity in a complex situation. However, far from being a reductionist approach, the model provides organization and direction to thinking. The result, then, is that new relationships might be seen and more importantly the conscious direction of thinking, with appropriate adjustments in contextual information, should encourage the reader to occassionally step outside his/her dominant mode of thinking allowing an expansion of existing knowledge. "The perceiver selects among properties and affordances by virtue of specific readiness for some and not for others" (Neisser, 1976, p. 171). The apparent simplicity of the model helps prepare the reader so that they are *ready* when new affordances are offered.

Second, the model provides a synthesized view of a framework that has been divided by analysis. It provides balance and integration between an introduction of the *players* and a holistic look at the *team* interaction dynamics. The following caution from Bruner (1983) provides an example of the importance of balance and integration. He states that "fields of psychology are important, for they deal with special contexts, make particularly revealing comparisons and sometimes even formulate powerful mechanisms. But in-so-far as they generate their own little kingdoms, each with its own set of bottled theories, they impede the progress of psychology by creating ad hoc realities designed to deal with local technical difficulties" (p. 277-278). A step beyond *information* to *transformation* is clearly required.

Finally, the third advantage of the format utilized in this inquiry is that by developing a holistic model based on the conceptual framework which is established, new generalizations about learning and performing may surface. "Generalizations that work are very precious things. They represent the essence of man's knowledge. They are distilled painstakingly drop by drop from the great mass of research" (Nirenberg, 1963, p. 155). The notion of creating generalizations is important. They enable a person to go beyond specifics and apply learning from earlier relevant situations, and also to act quickly enough to keep pace with a rapidly changing environment.

In undertaking any type of scientific investigation one must be careful not to delude one's self by thinking that some kind of permanent, ultimate truth will be an outcome. Such a thought would indeed be very naive, for history has shown that "the limits of knowledge set by the most visionary of men have in the end always been transcended" (Harth, 1982, p. 33). The value of scientific investigation is not that it provides man with ultimate truths, but rather it supplies a continual stock of basic material (information) required for learning and development to occur. In science it is the use of generalization that transforms the specifics of experience into hypotheses and theories, which in turn generate more specifics, and the cyclic nature of learning is established. In everyday life however, generalizations have a somewhat different function. "Instead of the automatic search for the most detailed level of explanation, there is a search for the simplest level of explanation that allows one to get on and do something" (Debono, 1967a, p. 37). Or in other words, there is a quick search for a generalization that works in this particualr situation at this particular time.

Furthermore, the significance of acknowledging generalization as an important foundational concept is that the use of generalizations may be related very specifically to **differences** between learning and performing. And the support for the function of generalization is found in the neuroanatomy of the brain.

When generalizations are called into play it might be assumed that functionally effective circuitry or neural patterning has been established. Through practice the efficiency of these pathways improves and the learner gradually rises to a *performance* level where action (and the generalization that drives it) is cue directed and occurs quickly and automatically. But when generalizations are not effective; when smooth neural integration is disrupted for whatever reason, a re-structuring of information must occur. This re-structuring operation is **learning** and it requires either the additon of new information into the system or a re-evaluation or re-ordering of old information. Interestingly, when one looks at the anatomy of the brain it seems uniquely suited for this function of formulating generalizations, which through practice become so automatic in specific situations that they appear no longer to be generalizations but rather specific, fine tuned responses. Harth (1982) states that "only about one in a thousand of the fibers entering the cortex at any point is an axon that comes from lower structures and brings in sensory information. All other fibers are either U-fibers or callosal fibers and this represents cortex talking to cortex" (p. 66). While effective learning and performance are, in the first instance (or at least at some point in the cycle), dependent on information input from the senses, once that is provided it creates a necessity for complex communication within the cortex that works at creating generalizations that guide thinking and behavior. This brain structure yields the possiblity of " reflection - a very apt description of thought" says Harth, (1982, p. 102) and it is by reflecting on information that impinges on the system that generalizations are made - and learning occurs. Then, it is through practice and rehearsal that these generalizations are refined to allow smooth automatic performance.

It is often apparent in performance situations that one of the major causes of performance detriments is *thinking too much* or being *caught up inside one's head.* This notion of the possibility of being **too** cognitive in performance situations is acknowledged and supported in the work of such researchers as Unestahl (1983), Gallwey (1974), Loehr (1983), and others, but it all relates to the fact that as Yogi Berra, one of baseball's all time great players supposedly once said, "you can't hit and think at the same time".

"The cortex literally reflects, bounces back images that have impinged on it, producing new and modified inputs for itself. At the same time it may send messages down motor pathways and play with the sensory echoes of such simulated action" (Harth, 1982, p. 102). This capability of *playing* with input is crucial for *learning* but many *performance* situations demand that the performer minimize this playing so responses can keep pace with the time constraints of the rapidly changing environment. Performers often simply don't have time to let inputs bounce around inside their head before settling on an appropriate response. Finding and practicing generalizations that work will allow performers to more readily "lose their heads and come to their senses" producing the most favorable performance situation results.

The following synthesis of the literature is intended to support and expand these key foundation components in addition to the primary goal of serving to guide the reader towards a holistic picture (a gestalt perhaps) of the critical variables influencing **learning** generally, and specifically **learning how to perform.**

SYNTHESIS OF THE LITERATURE

Ways of Thinking

As one begins to delve into the learning and performance literature it soon becomes apparent that it has been dis-integrated; it has already been *analyzed* , which is to say "resolved into elements or constituent parts" (American College Dictionary, 1962). In this inquiry an attempt will be made to determine the essential features of learning and performance that are concealed within the literature. But beyond this a synthesis approach will be taken, allowing a look into the interaction effects of the constituent parts, which, as will become more evident throughout, are truly at the heart of understanding learning and performance. The scientific measuring tool utilized to assist the knowledge acquisition process is the *model* presented in figure 2. "A model is a method of transfering some relationship or process from its actual setting to a setting where it is more conveniently studied" (Debono, 1969, p. 33).

The review is structured so as to first present a base, or stable platform, upon which further detailed operations of learning and performance variables can be grounded. Such logic should allow the information to become meaningful. However "meaning is not something that lies withing an object, but a description of the way the object affects the mind, the way it brings about or fits into a pattern of thought" (Debono, 1971, p. 141). As such, it is appropriate to identify two prevalent modes of thinking that seem to dominate most scientific discussions of human performance. They are mentioned here in an attempt not so much to dissuade the reader from using them, but rather to ensure the recogniton of such processes should they be engaged in. Because thinking is obviously related to learning and performing (in a variety of ways that will be acknowledged throughout this discussion) some awareness by the reader of their own thinking processes will provide valuable first hand evidence of the various ideas presented.

The first dominant mode of thinking relates to the ambiguity of the terms *part* and *whole*. "The two term part-whole paradigm is deeply engrained in our unconscious habits of thought" says Kesler (1967, p. 49). Furthermore, he goes on to state, "it will make a great difference to our mental outlook when we succeed in breaking away from it". The reason for this is that "wholes and parts, in the absolute sense, just do not exist anywhere" (Kesler, 1967, p. 48). What one finds in the circular systems of the human organism, involving countless feedback loops, is a collection of intermediary structures that operate as wholes and parts simultaneously. They are what Kesler (1967) has labeled "holons", from the Greek word 'holos' meaning whole, with the suffix 'on', as in proton or neutron, suggesting a particle or part (p. 48).

When trying to solve problems, one typically attempts to break it into parts, assuming that an understanding of all the parts might lead to an understanding of the whole. Unfortunately, as was previously alluded to in a statement by Brown (1980), qualities of the whole often transcend the physical elements of its parts, to say nothing of the futility of attempting to identify parts that may not even exist in isolation. The concept of the "holon" will be utilized throughout this review, as it lends itself to advancing an understanding of the dynamic nature of the learning and performance framework.

With regard to grasping an understanding, Nirenberg (1963) provides an appropriate reminder that "ideas are not absorbed by being pounded in from without. They are grasped by being reached for from within" (p. 200). Reaching for ideas from within is *thinking*, and people generally accomplish this feat by proceding from one bit of information to the next in the most obvious, straight forward line possible. This straight ahead, logical, step by step thinking is the second prevalent mode of thinking - "vertical thinking" (Debono, 1967a).

Vertical thinking is reinforced by the part-whole paradigm and in turn vertical thinking reinforces the part-whole method of thinking, which reflects, once again, the circularity of the system. Does the previous sentence make sense? Hopefully it caused some confusion. If so, tune in to what you did to figure out the meaning. Chances are you circled back around to the start and did the loop again, perhaps even reading slower as you attempted to identity the *parts* . You may then have decided that a part was missing because in attempting to stack the blocks up, one by one (vertical thinking), you came to a pair that didn't fit together properly. Then upon circling back and pulling in more information you most likely came up with the missing piece, or at least formed a hunch about what the missing piece was, and continued on your sequential, logical thinking way. However imagine that you couldn't come up with the missing link. What would happen? Typically a person would continue to go around and around, searching the same pathways that obviously don't contain the correct information to solve the problem. That is, or course, unless more new information was available that could be added to the system, which is likely what you expected to find as you continued to read on. The problem with this mode of thinking is that, while it is very effective for most of the information processing demands people encounter, it is not as effective when novel solutions are required, and it fails to recognize that the mind has the capacity to generate information for itself (Hart, 1982). Debono (1967a) defines the problem with this type of thinking most articulately. "You cannot dig a hole in a different place by digging the same hole deeper" (p. 14). The solution is "lateral thinking" says Debono. Unfortunately it is very difficult to explain what lateral thinking really is, because once it is explained the vertical process takes over and it all seems very *logical* , after the fact. An example, as presented by Debono (1967a) will serve as an appropriate conclusion to this section:

> Many years ago when a person who owed money could be thrown into jail, a merchant in London had the misfortune to owe a huge sum to a money-lender. The money-lender, who was old and ugly, fancied the merchant's beautiful teenage daughter. He proposed a bargain. He said he would cancel the merchant's debt if he could have the girl instead.
>
> Both the merchant and his daughter were horrified at the proposal. So the cunning money-lender proposed that they let Providence decide the matter. He told them

that he would put a black pebble and a white pebble into an empty money-bag and then the girl would have to pick out one of the pebbles. If she chose the black pebble she would become his wife and her father's debt would be cancelled. If she chose the white pebble she would stay with her father and the debt would be cancelled. But if she refused to pick out a pebble her father would be thrown into jail and she would starve.

Reluctantly the merchant agreed. They were standing on a pebble strewn path in the merchant's garden as they talked and the money-lender stooped down to pick up the two pebbles. As he picked up the pebbles the girl, sharp-eyed with fright, noticed that he picked up two black pebbles and put them into the money-bag. He then asked the girl to pick out the pebble that was to decide her fate and that of her father.

Imagine that you are standing on that path in the merchant's garden. What would you have done if you had been the unfortunate girl? If you had had to advise her what would you have advised her to do?

- What type of thinking would you use to solve the problem? You may believe that careful logical analysis must solve the problem if there is a solution. This type of thinking is straight-forward vertical thinking. The other type of thinking is lateral thinking.

The reader might want to take a couple of minutes to contemplate an answer before reading on. Debono offers his explanation:

The story shows the difference between vertical thinking and lateral thinking.

> Vertical thinkers are concerned with the fact that the girl has to take a pebble. Lateral thinkers become concerned with the pebble that is left behind. Vertical thinkers take the mo reasonable view of a situation and then proceed logically and carefully to work it out. Lateral thinkers tend to explore all the different ways of looking at something, rather than accepting the most promising and proceeding from that. The girl in the pebble story put her hand into the money-bag and drew out a pebble. Without looking at it she fumbled and let it fall to the path where it was immediately lost among all the others (pp. 19-21).

Vertical thinking will now easily take the reader the rest of the way towards determining the *logic* (?) of the solution and will likely lead to the feeling that there must have been a logical way of solving the problem all along. It is only in the appreciation of the difficulty of solving the problem before knowing the solution that the significance of lateral thinking can be seen.

The Nature of Knowledge

Any human performance, and athletic performance in particular, will most certainly be limited by physical constraints; constraints imposed by the structural capacity of all the organs and tissues of the body, including brain tissue. Advances in our understanding of how the human body can best function within certain structural constraints has contributed enormously to performance enhancement. Yet a burgeoning field of knowledge about the structural and functional capabilities of the mind shows signs of even greater potential. " ' I cannot escape', Harlow Shapley said, 'the feeling of a responsibility to glorify the human mind - even dream about its flowering into something far beyond the primitive muscle-guider and sensation-recorder with which we started' " (Cousins, 1981, p. 18).

Whether *mind is brain* or is *something more than brain* is still very much an unsettled issue. "Some digging into the facts behind evolutionary and genetic theory easily uncovers indications that nearly all the known evidence and theories of evolution are as strong grounds for the notion of mind-as-an-entity as they are for the notion that mind-is-brain" (Brown, 1980, p. 139). Regardless, the function of mind is thinking, or thought, and the result is knowledge formation or manipulation. For that reason, an improved understanding of the acquisition, organization, structure and use of knowledge will most certainly sharpen the present view of human performance and may even eventually shed some light on the mind/brain issue.

"Knowledge is based on past experience; behavior is based on knowledge" (Bruner. 1983, p. 110). If *knowledge* is accepted as the critical factor in the influence of behavior throughout one's life, the tacit relationship between knowledge and human performance must be the central feature of any discussion about people in action. Knowledge not only allows people to function adaptively within their own econiche but ultimately provides the means to direct the progress of that functioning. Most significantly, the structure and organization of knowledge appears to function in a self-maximizing manner. That is, "the system is built for learning". "Without adequate input, in the form of information, the cognitive system begins to deteriorate. To ward off cognitive malfunctioning, information seeking behavior is initiated" (Dember, 1974, p. 167). Carl Popper (1965) wrote of this knowledge accumulating (information seeking) process, "the more we learn about the world, and the deeper our learning, the more conscious, specific, and articulate will be our knowledge of what we do not know, our knowledge of our ignorance" (p. 28). While our *infinite ignorance* will ensure that no person ever lives a completley satisfying life, to the extent that each little bit of knowledge that is acquired allows us to more fully understand our relationship to this ignorance, learning is crucial. How, then, is knowledge acquired? In an attempt to answer this question many researchers have turned their thoughts, first, to trying to understand how knowledge is represented.

Knowledge Representation

The nature of representations of knowledge has occupied the minds of many theorists. While a good deal of variability exists among them (Kail and Bisanz, 1982), Bruner's (1983) view seems to be most powerful, primarily due to its simplicity and completeness. Three modes of representation (enactive, iconic, and symbolic) are distinguished. Respectively, "one is through habit and action;

knowing what to do. A second is through imagery depiction of events and relations. Finally, we *know* things by representing them in a symbol system like language or mathematics" (p. 142).

In contrast to the preceding *process* type of representation, Debono (1969) offers an intriguing structural representaton he refers to as a "special memory surface". To summarize his views in a necessarily brief description, knowledge is seen to be a functionally connected network of information units. The relationship between each unit, while related partially by their nearness in space, is more accurately represented by their nearness in "sympathy". "Nearness in sympathy is another way of saying functional connection" (p. 51). The combined capacity of a person's inventory of memory surfaces due to this functional connectedness is immense. In explanation Debono states "if you had a grid made up of ten boxes along one side and ten along the other [yielding 100 units], then the total number of different patterns that could be shown would be about ten to the twenty-seventh power" (p. 49). Recall that the brain is estimated to have one hundred trillion such units, not just one hundred. This creates the possibility of almost infinite information storage capacity. Thus it is not difficult to see how many theorist have come to agree on the following school of thought regarding properties of the human knowledge system:

> 1. There are, theoretically, no limits on the quantity of knowledge that can be stored.
> 2. Most knowledge can be accessed by multiple routes and multiple cues, reflecting the fact that knowledge is rich in interconnected links.

> 3. Knowledge is characterized by a weak form of congitive economy. Not all of one's knolwedge about concept X need be associated directly with X. Instead, some of this knowledge is available only indirectly via inference.
> 4. Knowledge is not lost; 'forgetting' reflects an inability to access knowledge.
> 5. A process can operate on itself as well as on other representatons and processes. (Kail and Bisanz, 1982, p. 50).

The difference between Bruner's and Debono's notions of the representation of knowledge may be tied up in a common problem of distinguishing between product and process. "Traditionally, knowledge refers to the product that is stored in memory as a consequence of our innate dispositon or invariant tendency to interact adaptively with the environment" (Newell and Barclay, 1982, p. 177). In addition, however, it seems equally true that knowledge is also the process by which the organism interacts with the environment (Newell and Barclay, 1982, p. 205). In attempting to describe a construct which can support this product-as-well-as-process view cognitive psychologists have come to rely on the concept of *schema* . "A schema is conceived of as a modifiable information structure that represents generic concepts stored in memory. Schemata represent knowledge that we experience - interrelationships between objects, situations, events, and of sequences events that normally occur" (Glaser, 1984, p. 100). A schema is "not only the plan but also the executor of the plan. It is a pattern of action as well as a pattern for action" (Neisser, 1976, p.

56). Since the product/process issue can be confusing, for the purpose of further discussion the *interaction.* of schemas is considered process, while the schemas themselves are product. If one at least tentatively accepts the concept of schema then it follows that a particular schema must exist as an entity at some level at any instant in time, and yet it is also in a state of constant flux, it is both product and process simultaneously. Schemas are both parts and wholes - they are "holons".

The way in which a schema operates as the structural basis for a knowledge representation system, might be indicated best by using a hypothetical example. Imagine that the letters which make up the words on this page are analogous to neurons in the brain or perhaps in research terms to pieces of data. By themselves they do not provide a great deal of information except as the rules of the English language apply to constrain certain patterns of letters to go together. As the letters are chunked together based on these rules the different combinations that form words add more meaning. Still more meaning is provided when words are linked into sentences, which are linked into paragraphs, which are linked into chapters etc.. At each level some type of different meaning is available and each level is influenced by specific rules which must interact appropriately with the set of rules below and above them. Each level has variables, they embed one within another, they represent different levels of abstraction, are active in that they arise from other schemas and effect still others, and each level may ultimately be evaluated as to how it fits into this active process. But to attain a clearer understanding of this *active process* it is the activity generated by the entire interaction of each of the levels that is the critical element.

The active nature of schema produces a circular interactive effect as "information passes both down from higher order schemas to lower ones and also back up from the lower order schemas to the higher ones" (Norman, 1981, p. 4). The bottom-up, perception to knowledge, process appears obvious to most people; our actions are certainly influenced by what we sense from the environment. However, top-down, knowledge to action, processes are equally important (and obvious after the fact). "When the environment is stable how else can the organism produce different actions and attempt different acts but through conceptually driven procedures" (Newell and Barclay, 1982, p. 188)?

Within this "heterarchical" (top-down and bottom-up) framework, Norman and Shallice (1980) have distinguished two levels of schemas; *source schemas* and *component schemas*. Norman (1981) later referred to these levels as *parent* and *child* schemas. In this framework, component (or child) schemas are activated following the activation of "higher order" source schemas. However, logically it is not clear how it would be possible to attach such labels, since in a circular system, where top influences bottom and bottom influences top, no apparent dominance or starting point could be identified. Such a distinction may however be useful in clarifying a complex situation which may then aid in developing an appreciation for how thinking is directed and learning occurs. For example, it can be related to the concept of conscious control operating at a "higher" level with subconscious execution being carried out at a lower level (about which more will be said later). Norman and Shallice also provide another significant (for this inquiry) feature in that they perceive schema to exist in one of three states; dormant, activated (getting ready to be called upon - approaching threshold value), or selected (the actual active schema(s) involved at the time). Such conceptualization appears to fit well with known facts about the inhibitory and excitatory nature of neural synapses but also may reflect on a possible control feature with regard to lateral thinking and the difficulties with it's activation. Encounters such as an *ah ha!* experience, when a new idea suddenly jumps into ones head, may be at least partially explained by this feature, and the concept of *tuning the system* (being ready for action) may also be relevant here.

The discussion will return to the value of the schema concept later. At this point it is primarily important to note that "the exercise of a schema is the process through which future knowledge is acquired" (Newell and Barclay, 1982, p. 186). Does "exercising a schema" then mean *thinking?*

Before concluding this section on knowledge representation a caution from Harth (1982) is appropriate: "Our capacity for deceiving ourselves about the operations of our brain is almost limitless, mainly because what we can report is only a minute fraction of what goes on in our head" (p. 121). The structural and functional complexity of the system being dealt with must be kept in mind. The human brain contains billions of interconnected neurons (Wall et al., 1985), up to a hundred trillion synapses (Crick, 1979; Hubel, 1979) "whose strength and precise distribution determine the precise **dynamic** properties of the brain" (Harth, 1982, p. 95). Beyond these structural features, some thirty different chemical neuronal transmitters have been identified and "the superimposition of these diverse chemically coded systems on the neuronal circuitry endows the brain with an extra dimension of modulation and specificity" (Iversen, 1979, p. 134). Thus it is not too difficult to see how Harth (1982) could conclude that there is "absolute uniqueness of every brain" (p. 96), and it is this element of human uniqueness that is essential to remember as this discussion procedes.

Knowledge Acquistion

In this section an attempt will be made to shed some light on why "the acquisition and representation of knowledge are interdependent complementary processes" (Newell and Barclay, 1982, p. 186).

The "holistic model of the development of skilled action" presented by [illegible] et al. (1985) provides a recent focus on knowledge acquisition. This work, based largely on the work of Newell and Barclay and on the structural features of Norman and Shallice's information processing model of the control of action, has two particularly notable features that are relevant within the present context. First, they propose an interactive system of three broad knowledge domains; procedural, declarative, and affective knowledge. "Declarative knowledge refers to the storage of information about something ... procedural knowledge refers to how to do something ... and affective knowledge refers to an individuals subjective feelings" (Wall et al., 1985, p. 29). The concepts of *metacognition* , "knowing what one knows or does not know" and *metacognitive skills* , "used to procedurally control cognitive activity within skill learning situations" (Wall et al., 1985, p. 39) are also central features of their model. Different kinds of learning opportunities (experiences) may produce specific changes within each knowledge domain. But any given increment in learning will always be the result of the integrative outcome of all three knowledge domains working together under the influence of a higher order integrating domain. The division of knowledge into such a three part *holarchy* (hierarchically arranged holons) serves an important heuristic purpose. It allows "an examination of the major interactions that take place among different types of knowledge about action which are crucial to the motor development process" (Wall et al., 1985, p. 28).

The second particularly notable feature of Wall et al.'s framework relates to their views on the *conscious control of action* and its relationship to knowledge acquistion. While conscious control seems crucial for **learning** situations that are technically difficult, dangerous, or novel, all aspects of **performance** do not require conscious awareness. "It is only when something unfamiliar occurs and trouble-shooting is needed that the learner again becomes more consciously aware of specific components within the action sequence" (Wall et al., 1985, p. 34). These observations have particular significance relative to questions such as; what is the difference, if any, between learning and performing situations (especially fairly routine performance situations)? Or what kinds (or amounts) of knowledge have highly skilled performers acquired that less skilled individuals are lacking? More importantly, how did they acquire it? With regard to questions such as these the role that subconscious and conscious activity plays in learning and performance situations will be discussed in more detail in another section. The instantiation of both processes, however, is greatly influenced by *metacognitve* activity. Therefore to form a more complete understanding of the knowledge acquistion process a detailed description of metacognition follows. Further to this a brief overview of Norman and Shallice's "activation-trigger-schema" model will be presented as it provides important insights that link knowledge and the control of action to schema theory.

Metacognition

"Metacognitive knowledge about action refers to a person's awareness of procedural, declarative and affective knowledge about action" (Wall et al., 1985, p. 32). It is an awareness of what we do, how we do it and how we feel about it. At its highest level it is also an awareness of how these three specific awarenesses interact within each momentary contextual framework. The acquisition of metacognitive knowledge is analagous to what Herbert Feigl (as cited in Harth, 1982) has called "knowledge by acquaintance". That is, knowledge "derived from one's own introspective acquaintance with one's own brain states" (Harth, 1982, p. 238). In Glaser's (1984) terms metacognitive knowledge is "conditionalized knowledge" and it characterizes effective thinking. It is "knowledge that becomes associated with the conditions and constraints of its use" (p. 99). The functional significance of metacognition is that it provides the knowledge base with an information organizing operation.

This organizing ability of metacognition is not static but develops via an increased awareness of (a) **sensitivity** to those situations requiring skilled action and (b) knowledge of **variables** or factors which affect the outcome of action (Newell and Barclay, 1982, p. 187). Re-stating Newell and Barclay's explanation, "sensitivity" refers to an awareness of the nature of the problem and its context. "Sensitivity cues the individual to organize an appropriate schema or orientate to an environmental cue and subsequently tailor it to the specific problem at hand" (p. 188). With regard to "variables", three types are recognized and they provide the system with further organizational information. These are the "person", the "task", and the "specific strategies". *Person* variables are divided into *traits* - physical structure limitations relating to the degrees of freedom afforded, and *states* - limitations provided by one's awareness of ongoing action via proprioceptive and exteroceptive feedback relative to a particular goal. State variables are strongly influenced by learning. *Task* variables refer to the awareness of movement complexity. Deciding whether a task is easy or hard is based on actual experience or on "generalized" (constructed) knowledge from experience in a class of tasks with similiar characteristics". (Such a notion is supported by Schmidt's (1983) views on "elaboration" and also by Piaget's ideas of "assimilation and accommodation"). Strategy variables reflect a person's approach to problem solving. As one's experiences accumulate, knowledge is acquired regarding a continuum of useful strategies, from specific to general, which can be used for both analyzing the requirements of learning new actions or for generating responses which appropriately modify existing patterns. The interactions of *sensitivity* and *variables* and the development of conscious awareness of this interaction is metacognition.

> Through time and experience the individual comes to understand intimately his/her physcial reality, the reality of the surrounding world and how that world relates to his/her movement. With this understanding the individual can **predict** the effect of the constraints prior to moving and thus **plan** an appropriate movement that successfully matches or deals with these constraints; or indeed extract constraining information during performance and modify a movement in course. In essence, the individual develops motor control and strategies to direct motor control" (Arend, 1980, as cited in Wall et al., 1985, pp. 33-34).

Metacognitive knowledge develops out of problem solving behavior as well as directs problem solving behavior. This reciprocity is not surprising as it appears to be congruous with the underlying schema network which is assumed to support it. The circularity would predict that metacognitive development and its consequent higher level , self-regulatory and organizational behavior, should increase with experience. In fact Wall et al. (1985) cite seven studies which support such an assumption.

Norman and Shallice

Extending the notion of *active* schema, Norman and Shallice describe a "flow of processing". Attentional and motivational mechanisms are said to "only modulate the flow of processing" (p. 12). Specifically this "flow" may be related to the electrical and chemical activity which travels through the neuronal network in the brain via excitatory and inhibitory synapses. The impulses which are generated for the execution of well learned tasks will normally meet little inhibiting resistance from connecting networks. These well traveled paths are represented in Norman and Shallice's model as "horizontal threads" and the combination of excitatory and inhibitory synapses along the way can be viewed as giving the schema network, which these threads connect, an "activation value". A schema that is run off completely through these horizontal threads is said to be *automatized*. In Wall et al.'s terms it is "well established procedural knowledge".

Schema networks are seen as having three activational influence sources; *vertical threads, contention scheduling,* and *trigger conditions.* Since many schemas are normally active at any time, and because they often share the same neuronal space, conflicts can occur when one unit is required simultaneously by two networks. These problems are handled by "contention scheduling" mechanisms. If however no such interference occurs then the environmental stimuli simply "triggers" the appropriate schemas. "Planning and decision making processes are needed when existing schemas are not able to satisfy a goal" (Wall et al., 1985, p. 26) and in these situations new schema networks are generated by the activation of "vertical threads" - the conscious control networks used when problem solving.

Significant aspects of Norman and Shallice's work, in the context of the present discussion, are that their model reflects the possibility of action being controlled at both a conscious and subconscious level; that knowledge is organized in a "heterarchical" fashion; that schemas are not static but the strength of their links can change with practice and entirely new connections can be made; and that trigger conditions (environmental inputs) require only "sufficient" similiarity from time to time, rather than an exact match, in order to exert their influence.

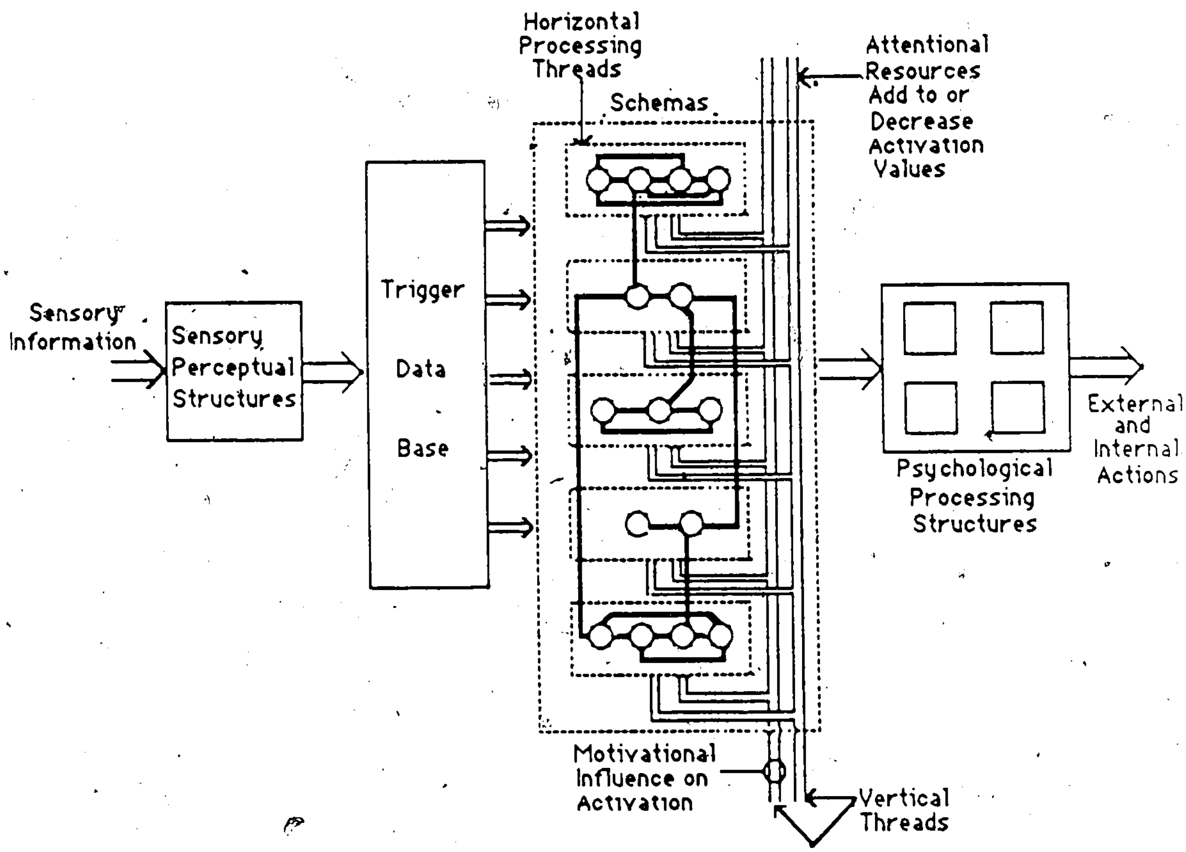

Figure 1 - Vertical threads. When attention to particualr tasks is required, vertical threads are activated. Attention operates upon schemas only through manipulaton of activaton values. Thus attentional processes oversee and bias ongoing action by alteration of activation values. Motivational variables are assumed to play a similiar role in the control of activation, by working over longer time periods (from Norman and Shallice, 1980).

The Knowledge Base in Operation

In the preceeding pages the rationale for the idea of *knowledge* as a fundamental contruct related to learning and performance was presented. In addition some possibilities with regard to the representation and acquisition of knowledge were presented. Based on this the concept of a **knowledge base** has been created. This knowledge base is assumed to grow through the accumlation of the various perceptual experiences that each individual has throughout their lifetime (Wall et al., 1985; Newell and Barclay, 1982; Neisser, 1976). In this section the meaning of experience will be evaluated through a more detailed look at the *working features* of the knowledge base; features of experience that bring about or fit into a pattern of thought. If knowledge is "the representation thought synthesis of one's varied experience" (Newell and Barclay, 1982, p. 197) then it is crucial that the meaning of experience be considered. How does experience alter or adjust schemas (cognitive structures)?

Throughout the discussion to follow it is imperative that the function of *time* be acknowledged. All human thought and action requires time, or more accurately, becomes manifest over time. The organism-environment interaction can not, in reality, be frozen in time at any moment. Yet in order to simplify complex human function it seems necessary to look at isolated instances. The accuracy of the readers thought depictions may be enhanced by seeing each *working feature* as fitting into the following image. Imagine a long tube bent to form a ring. Inside the tube at various locations sit the working features. Now take several such rings, place them flat, one on top of another and watch the activity constantly surging around each ring from feature to feature with varying speeds. Connecting the rings together through the middle is a dominant knowledge base. This connection allows for communicaiton to flow between the rings and back and forth, to and from, the knowledge base and the ring framework. At any moment the system as a whole is undergoing some degree of change and any discussion of learning and performance should somehow reflect this dynamic function.

The circular nature of this image not only reflects the importance of time but also effectively illustrates the difficulty of distinguishing product from process. "What is product at some particular moment in time could merely be part of the ongoing process, and this problem is magnified when different levels of analysis to issues in the representation of knowledge are considered" (Newell and Barclay, 1982, p. 177).

In an attempt to maintain the image of a circular operating system, which is set to encourage the identification of interaction effects, it will be useful to present a summary of the operation of the learning and performance model as it is presented in figure 2. Following this a more detailed explanation of the functions of each working feature will be considered.

The first thing to notice about the model is the dynamic circular interactions; (a) the reflective response cycle incorporating the knowledge base; (b) the automated response cycle incorporating environmental information; and (c) the guided response cycle which is really an integration of the previous two cycles. This circular nature effectively avoids the product-process dichotomy.

The energy to drive the system comes from two sources in the form of information (data or cues). The *active* information in the knowledge base which produces a series of *intentions* (mental data) is combined with environmental data and results in the creation of a *context* , or more precisely a series of moment to moment contexts. The integration of these two sources of information is the act of *perception* . Furthermore within the intention to action cycle *expectations* arise. When one intends to do something, simultaneously there is also an expectation of a particular outcome if a response is initiated. Thus, moment to moment contexts are made up of expectations and perceptions of the information impinging on the system, and it is the evaluative interaction of these two features that determines the responses that will be selected.

When expectations and perceptions match the procedural plans which are carried in the activated intentions can be acted on automatically (without conscious input). Action is initiated and the critical means of feedback, are indirect, through corresponding changes in the environment. When perceptions and expectations conflict (mismatch) conscious problem solving activity is initiated and reflective or guided responses result.

To procede further one must understand that contexts within contexts are possible. It is something akin to having long range goals and short term objectives designed to meet these goals. At some point in time two (or more) distinct goals or objectives (intentions) may come in conflict with each other. Thus the perception is one where the corresponding expectations conflict. In this instance the response is conscious and reflective. That is, the knowledge base and its' consequent formation of intentions must be reorganized or new knowledge added in order to satisfy the conflict by formulating cooperative or sequential intentions. (Note that another level of analysis has entered the discussion). Perception, then, not only has a role in the immediate evaluation of the environment but one can also perceive one's own thoughts in an after-the-fact way.

When a conflict between expectations and perceptions occurs as a result of the environmental information not matching the knowledge base information, then both sources of information are evaluated to determine where the mismatch occurs. The resolution of this mismatch occurs when either the environment is re-evaluated and the correct cues found or the knowledge base if reorganized. This *guided response* is an example of the sort of backstepping that occurs when making a **sufficient** action more **efficeint**. (The discussion will return to this point later). Often previously learned automated responses must be re-evaluated, in order to change the cue-response structure and the mental framework associated with this new information network.

These types of response modes arising out of moment to moment contexts seem to parallel quite closely Brown's (1980) "three-part operation between mind and body". The automated response is roughly equivalent to her description of an "unconscious intelligence that can absorb information from the environment, recruit both physical and mental abilities, and act on informaton quite appropriately no matter how complex". The guided response mode reflects "a conscious awareness that can sometimes appreciate events in the unconscious" (ie. it *tunes in* to what is happening automatically). Finally the reflective response resembles a "conscious awareness that relies on social consensus about the proper behavior of both mind and body" (p. 69).

The dynamic nature of the learning and performance system is limited by the two dimensional representation of the model. If, however, several copies of the page with the model on it were made and then stood up one behind the other and connected by one large knowledge base, the capacity of the model would be more accurately represented. Contexts within contexts, multiple intentions and expectations, as well as conscious activity occurring simultaneously with subconscious activity is possible. In addition all three response modes could operate at the same instance, or more accurately stated, any given observable action may be a result of the three types of responses working in concert. Reflecting on the known facts of brain structure, with trillions of linked synapses operating at very high neural transmission speeds, such an operating potential of the model is conceivable.

The importance of these working features (ie. the context, perception, expectation, intention, and the environment) is that these are the areas that must be altered in some form in order to alter the knowledge base. Some implications of this statement with regard to learning (expanding the knowledge base) and performance will be presented in the *discussion* chapter.

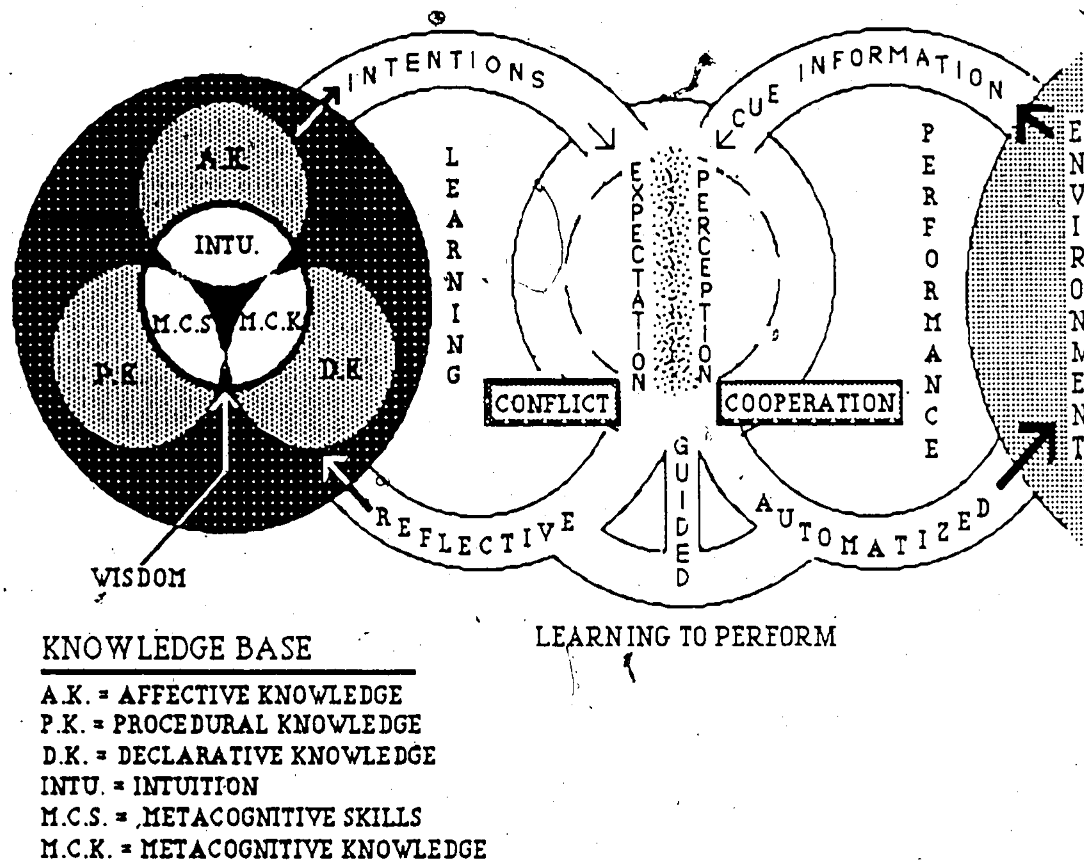

Figure 2 - Diagramatic representation of a metatheoretical learning and performance system. The model is representative of the circular interactive features of learning, learning to perform, and performance situations.

The Working Features in Isolation

A. The Knowledge Base

In order to represent the possibilities which exist for beneficially altering the knowledge base the functional nature of this information storehouse is simplified, but hopefully not distorted, in the structural representation observed in the learning and performance model. The knowledge base, as presented here, comes directly form Wall et al.'s (1985) metatheoretical perspective. Like Wall et al.'s model, the knowledge base is presented as a highly dynamic, shifting, developing entity - considered at a brief moment in time; frozen in a micromillisecond, rather than as a stable continuing entity. The difference is that the present model expands on the notion of *interaction* and includes a more visual presentation of an *integration* concept.

In Wall et al.'s (1985) model (figure 3) an interaction effect is shown by representing the three general knowledge domains in a Venn Diagram. Thus, for example, one's emotions and their knowledge of what they know will most certainly have great effect on the procedural operation of any action sequence. In fact, trying to get an optimal balance and interaction between these domains might be considered to be a principle focus of learning and performance in sport and other areas of human activity. In Wall et al.'s model this interaction effect is related to the function of metacognitive knowledge and metacognitive skill. However there still seems to be something beyond a "higher form" of declarative knowledge; beyond consciously knowing what one "can and can not do". This seems particularly obvious in the performance of great artists/athletes. Most commonly this *something* has been explainable in verbal terms as *intuition* (a subconscious awareness of what one can and can not do). If metacognitive knowledge is a higher form of procedural knowledge (Wall et al., 1985), the powerful force that can best be expressed as intuition, could (or perhaps should) be considered a higher form of affective knowledge. While it is clearly beyond present capabilities to quantify or measure this phenomenon, it is well recognized by performers in every field, from business to dance, and on that ba[illegible]s to be included in any model of learning and performance. The expression "I've just got a gut feeling about this" reflects an instance when intuition is appreciated by metacognitive thought, but this appreciation most often cannot be pushed any further into consciousness without considerable difficulty (and it may not even be desirable to do so).

THE DIAGRAM HAS BEEN REMOVED BECAUSE OF THE UNAVAILABILITY OF COPYRIGHT PERMISSION. THE DIAGRAM SHOWS THE RELATIONSHIP OF WALL et al.'s KNOWLEDGE DOMAINS IN THE FORM OF A VENN DIAGRAM. (WALL, BOUFFARD, McCLEMENTS, FINDLAY, AND TAYLOR, "A KNOWLEDGE-BASED APPROACH TO MOTOR DEVELOPMENT: IMPLICATIONS FOR THE PHYSICALLY AWKWARD", ADAPTED PHYSICAL ACTIVITY QUATERLY, VOL. 2, PP. 21-41, 1985.

Figure 3 - Relation of metacognitive skills and metacognitive knowledge to the three major types of knowledge about action that develop (Wall et al., 1985).

The influence of metacognition on the learning process is clearly acknowledged by Wall et al. (1985). As metacognitive awareness of each knowledge domain increases with every new experience, the way in which the actions of each domain influences the others is represented by the connecting circles in the model. (Having the circles just touch but not overlap, in the author's model (figure 2), reflects a belief that although each domain *interacts* with the others there is an operation that occurs at a higher level that provides an *integration* function). Because of the dominant consciousness overtone associated with metacognition, one step beyond this seems to be required in order to integrate the subconscious and thus allow a more complete depiction of significant operating features of performance, as well as those of learning. The conceptualization of *wisdom* as an integrating process reflects this need to go beyond interaction. This distinction is made primarily to point out that, while interaction is the means by which integration must occur, the way in which this interaction occurs is quite variable. The best performers display superior integrating abilities. This *wisdom* leads directly to more *proficient* interactions between the different domains and thus better stimulation for the development of the knowledge base.

Wise people seem to be able to take a great deal of information and fit it into their knowledge base. But in addition they take that extensive knowledge base and organize it in a manner which allows them to express their views simply yet completely. They seem to see through the complexity of the world; they are performers that understand the game and themselves well enough to perceive its simplicity. They continually, and seemingly with relative ease, "go beyond the information given". They are the people who just seem to *have* the answer when everyone else is madly trying to think their way through to it.

This leads to the idea that best performances result when the task, the environment and the variables within the individual are integrated. The choice of wisdom as the name for this integrating feature and the addition of intuition on to Wall et al.'s model comes mainly from a belief that Eastern philosophy has much to offer the student of learning and performance. Taoist philosophy, for example, states "the master's of life know the way, for they listen to the voice within them, the voice of wisdom and simplicity, the voice that reasons beyond cleverness and knows beyond knowledge" (Hoff, 1982, p. 154). Most simply, Hoff adds, "the wise are children that know" (p. 151), so perhaps it would be appropriate to end this section with some wisdom from Winnie the Pooh.

> "Rabbits clever", said Pooh thoughtfully.
> "Yes" said Piglet, "Rabbit's clever",
> "And he has Brain".
> "Yes" said Piglet, "Rabbit has Brain".
>
> There was a long silence.
>
> "I suppose" said Pooh, "that that's why he never understands anything" (Hoff, 1982, p. 15).

B. Context

"The number and complexity of representations that can be stored in the knowledge base are virtually limitless, but only a very limited subset of knowledge is *active* (ie. involved in processing) at once" (Kail and Bisanz, 1982, p. 31). The construct which best represents this active portion of the knowledge base is *context*. Building on Newell and Barclay's definition of knowledge and encorporating Magill's (1983, p. 368) view of context the following comprehensive definition is proposed. Context is the representative integration of the conglomerate of knowledge about specific aspects of the immediate situation. "Whether learning a new skill or performing a well learned one, the nature of the individuals involved, the character s s of the task being performed, and the environmental setting of the activity, must be viewed as candidates for determining context effects" (Magill, 1983, p. 368). In addition the *interaction effects* of the task, individual, and environment must also be determinants of context.

In metaphorical terms context might be viewed as the control gate to the knowledge base, letting information out as well as affecting what goes in. The use of an example might clarify and substantiate the knowledge-context relationship. If the previous section were read over again chances are some amount of new information or meaning would be obtained beyond that of the first reading. Related to the individual context which the reader had during the first reading the information will be received in a certain way. "We can only see what we know how to look for" (Neisser, 1976, p. 20). Having read the section once will activate different knowledge structures which will change the context for the second reading. This new context may then provide new insights. Clearly context and knowledge interact in a manner which makes it impossible to distinguish which comes first. The significance of context is that, at this level, some control over changes in the system can be gained, thus creating an opportunity to purposely alter the knowledge base.

If the example above is extended so that the section is read several times, at some point no new meaning or information would be picked up. With each reading certain features of the information would be continually reinforced until eventually they became "globally redundant" (Baars, 1983). Repeated information strenghtens thought patterns and yields a stable context of some global format. In the above example, knowledge contained in the section would become established in specific contexts as patterns (or representations). As a pattern gets increasingly reinforced from repeated readings it more completely directs the progress of thought and inhibits the activation of other potential interactive knowledge structures, including those that might keep motivational levels high. At this point then, in order to change the knowledge that is directing these established patterns, so that additional learning is possible, some change in the task, individual, or environment must occur which presents a new context. The strong implication here is that the acquisition of *new* knowledge (for mental or physical tasks) requires the establishing of a context different from the one which is presently directing the progress of established thought patterns. Changing the context causes a temporary disruption in the established schema network and forces the system to problem solve thus altering the knowledge base. Think back to the "lateral thinking" concept for a clear example of contextual operations.

The following quotations selected from the literature clearly indicate a need to determine the role which context plays in the activation and selection of knowledge structures:

> 1. "In real-world tasks the context serves to isolate the stimuli to be expected and limit possible responses" (Kerr, 1983, p. 53).
>
> 2. "The 'expectational set' influences what one perceives, and what one perceives can influence what one expects to perceive" (Brown, 1980, p. 167). Note the circularity.

> 3. "Distinctiveness emphasizes the contrastive value of information, and this of course presupposes a context from which distinctions are made" (Shea and Zimny, 1983, p. 39).
>
> 4. "Even the 'conditioning' of simple automatic responses is generally influenced by context and intent" (Neisser, 1976, p. 96).

C. Perception

At this point envisioning the operation of the model becomes more difficult because of the dynamic, circular nature of the system; because the working features behave as parts and wholes at the same time. However if one assumes, for now, that the central purpose of the knowledge base is to establish the context of a given situation; then the function of perception (which plays a critical role in the influencing of the context control gate) might be more easily recognized. The establishment of a momentary stable framework - a context (a kind of mini-knowledge base), allows perception of any stimulus. Without such a backdrop against which the contrastable value of incoming information could be evaluated, no meaning could be given to the stimuli. With regard to this operation, Bruner (1983) states that "the information value of any input to a system had to be computed in terms of what the system was ready to entertain by way of a set of alternative inputs. So perceptual readiness is as crucial a feature of the act of perception as the nature of any input to the system" (p. 277). Neisser (1976) further explains, "whether you see the meaning of a smile or just its shape depends on which sort of cycle you are engaged in, not on any single instantaneous input and its processing in your head" (p. 72).

Perception, says Brown (1980), is "the mental process of attaching meaning to sensation" (p. 14). That it is more than simply the pick-up of information, that is always available and specific, is easily substantiated by the mere existence of illusion and error. Equally true, however, is that perception is not merely the slave of bygone probabilities. "In perception we are obviously tuned to both the momentary likelihood of events and the dictates of the real world" (Bruner, 1983, p. 85). Unfortunately efforts to determine which aspect of this dual feature of perception exerts more influence on the control of action have not yielded any particular value for a very long time. "Twenty-four centrüies ago Democritus described this seesaw battle in his famous dialogue between the mind and the senses. First, the mind chides the senses, pointing out that their qualities of color or taste are only matters of convention. The senses answer; 'Ah, wretched intellect, you get your evidence only as we give it to you, and yet you try to overthrow us. That overthrow will be your down fall'" (Harth, 1982, p. 159). In a circular system where the activity which surges around it is self-perpetuating, constraints are self-imposed by ongoing changes in the system. Neither sensation nor intellect can ever become dominant in the system, for they must necessarily rely on each other, each equally limiting the other.

Perception is a working feature that is formed because of the creation of a context (where knowledge and information unite) and at the same time helps create the context. Because the active portion of the knowledge base contains the capacity to evaluate information the process of perception is created. And because, through the process of perceiving, meaning is derived, new meaning creates the possibility of altering the knowledge base - and the cycle continues. Neisser's (1976) "perceptual cycle" (figures 4 and 5) helps to clarify this relationship. He decribes the cycle as follows:

> Perception is indeed a constructive process but what is constructed is not a mental image appearing in consciousness where it is admired by an in er man. At each moment the perceiver is constructing anticipations of certain kinds of information, that enables him t accept it as it becomes available. Often he must actively explore the optic array to make it available, by moving his eyes or his head or his body. These explorations are directed by the anticipatory schemata, which are plans for perceptual action as well as readiness for particular kinds of optical structures. The outcome of the explorations - the information picked up - modifies the original schema. Thus modified, it directs further exploration and becomes ready for more information (pp. 20-21).

THE DIAGRAM'S IN FIGURE'S 4 AND 5 HAVE BEEN REMOVED BECAUSE OF THE UNAVAILABILITY OF COPYRIGHT PERMISSION. BOTH DIAGRAM'S WERE TAKEN FROM NEISSER'S 1976 BOOK TITLED COGNITION AND REALITY, PUBLISHED BY W.H. FREEMAN AND COMPANY, SAN FRANCISCO, PP. 20-21. FIGURE 4 SHOWED NEISSER'S "PERCEPTUAL CYCLE" AND FIGURE 5 SHOWED AN EXPANDED VIEW OF THE PERCEPTUAL CYCLE INDICATING HOW SCHEMATA IS EMBEDDED IN COGNITIVE MAPS.

Implicit in this cycle (as is represented by the difference between figure 4 and 5) is the fact that both the internally generated knowledge and external information cues available at any moment are limited. Context represents the limited knowledge available, while the information available is limited by the capacity of the perceptual cycle to integrate information.

In an attempt to reduce the limits that this system imposes, the concept of *attention* has received considerable attention. Attention has become a strategy of perceiving. Unfortunately this strategy has often fallen into the trap just previously described by Democritus. Attention theory has focused on the environmental information side while for the most part ignoring the significance of the knowledge-context side. Bruner (1983) refers to the importance of enhancing the ability to learn more about what to sample of the environment through our "peephole perspective" but goes on to state that basically that that ability is of lesser value without the corresponding development of the ability to learn more about what to make of this more selective information cloud (p. 276). Neisser (1976) sums up the inherent problem most succinctly when he states "choosing where to look is not the same thing as choosing what to do" (p. 182).

Perception is "an activity that takes place over time - time during which the anticipatory schemata of the perceiver can come to terms with the informaton offered by the environment" (Neisser, 1976, p. 9). Identifying important environmental cues can be valuable but not without a corresponding attempt to identify and learn how to generate contexts that allow those informational cues to be perceived when they need to be perceived.

D. Intention

Tolman, some time ago, coined the phrase "behavior reeks with purpose". The formation of intentions are the plans on which purposeful behavior is based. Intentions can take a general form such as long term objectives or goals that reside in the knowledge base. These intentions may then, in turn, through the influence of the context, give rise to more specific intentions. Intention is "a decision to take certain action (which may be a decision to take no action) based not only upon consideration of the value of the goal, but also upon estimates of the relative effectiveness of possible alternative actions and a consideration of what the consequences of different actions will be" (Brown, 1980, p. 265).

Intention is that portion of the self-perpetuating activity of the schema system which determines the search for some particular information and not some other. Specifically activation of the highest level parent schema is equated with the formation of intention (Norman, 1982, p. 4). Norman states "the formation of an intention is the result of many considerations, including the overall goals of the person, decision analysis, problem solving activities, situational analysis and so on" (p. 5). Clearly intention must be considered as an interdependent feature of a continually constructive learning and performance system. It is influenced by both context and perception.

The influence of intention on action is most evident in Norman's (1981) treatise on *action slips*. "A slip is a form of human error defined to be the performance of an action that was not what was intended. ... From an analysis of slips of action it is possible to construct the outline of a theory of action that suggests how an intention is represented and acted upon" (p. 1). Intention is an incontestable feature in the reciprocal process of knowledge to action. But how do intentions exert their influence?

E. Expectation

"Expectations are multidimensional, subjective activities that depend upon individual history, and are determined and modified by, and linked to, one's aspirations [intentions]" (Brown, 1980, p. 97). In the continuous stream of schematic activity through the knowledge-action cycle, expectations serve to activate schemas for upcoming actions. Utilizing the terminology of Norman and Shallice's "activation-trigger-schema system", expectations represent "activated" schemas, where the strength of the activation parallels the dominance of the expectation. Perception, on the other hand, represents the means through which trigger conditions raise the activation value to a level sufficient for "selection". These trigger conditions are seen to arise out of interactions of the task, individual and environment. More specifically, multiple sources of activation come "from the external world (data driven activation), from internal processing (thoughts, association, prior or future action components), or by capture by well-learned familiar habits" (Norman, 1981, p. 14).

The comparative function of the interaction between expectations and perceptions is of considerable importance. It relates to the belief that "in order for discrepant behavior to be detected two things are necessary; a feedback mechanism with some monitoring function that compares what is expected with what has occurred [perception], and a discrepancy between expectations and occurrences" (Norman, 1981, p. 11). "The existence of such feedback mechanisms", Norman goes on to state, "seems a logical necessity in the control of human behavior", and to say that discrepancies between expectations and occurrences must occur before discrepant behavior can be detected seems almost too obvious. However this latter point has particular relevance to the impending discussion on consciousness.

The nature of the type of feedback system that is believed to operate in this perception-expectation comparative system gains support from recent neurophysiological findings. Gallistel (1981) refers to an interaction between "reafference and efference copies". In this framework an "efference copy" of efferent (outgoing) action commands is created and momentarily stored as each new act is initiated. The sensory (afferent) inputs generated as a consequence of one's own action - "reafferences" - are then compared to the efference copy and judged according to their degree of fit.

> Efference copies are low level, neurophysiologically explicable instances of expectations. They are centrally generated signals that anticipate forthcoming sensory signals. They are, of course, unconscious expectations. But when these unconscious expectations are violated, the difference between expectation and outcome shows up in conscious experience" (Gallistel, 1980, p. 6).

This is what happens frequently when one is engaged in technically difficult, dangerous, or novel activities.

The interacton between perception and expectation, most significantly, appears to be the feature which determines how consciousness comes into play. Bruner (1983) speaks of the matching or mismatching of a hypothesis that is continually created based on the assertion that people are never indifferent, always tuned, ever readier for some events than for others. Input from the environment is seen as either matching or mismatching the hypothesis and if it mismatches, the hypothesis will be changed or the perceptions adjusted until a match occurs. But "the stronger a hypothesis the less matching information is necessary to confirm it and the more mismatching information to disconfirm it" (p. 95). This relationship is reinforced by Brown's (1980) statement that "no perceptions can be unfavorable unless there are prior expectations of something other than that which is perceived" (p. 96). For example, how does one know when they haven't made the "perfect golf swing"? The activation of consciousness through this interaction is reflected in Ornstein's (1972) comment that "if the input and the model agree, as they do most often for the constancies of the world, then the input stays out of consciousness" (p. 47). As a result, one is often left with only a *feeling* of the aesthetic experience. The flow chart in figure 6, while designed by Brown (1980) to indicate the mental operations leading to distress, indicates demonstrably an expectation-perception interaction effect. In this model, if *well-being*, resulting from a match between perceptions and expectations, is replaced by *subconscious activity*; and *worry*, resulting from a mismatch between perceptions and expectations is replaced by *conscious activity*, the chart takes on even greater significance as it relates to the present discussion. It should also be noted that *differences* don't always result in worry, but may in many instances produce interest, excitement, and stimulation as a result of being perceived consciously as presenting a *challenge*. Herein lies one of the positive values of consciousness.

THE CHART HERE HAS BEEN REMOVED BECAUSE OF THE UNAVAILABILITY OF COPYRIGHT PERMISSION.

Figure 6 - Flow chart of mental operation leading to states of well-being or stress reactions (Brown, 1980, p. 105).

F. Conscious and Subconscious Activity

Hoff (1982) reports the Taoist maxim "to attain knowledge, add things every day. To attain wisdom, remove things every day" (p. 149). The significance of subconscious processing, automatization; the removing of things from consciousness, is most apparent in performance research today. While the role of *habituation* was suggested as early as 1890 by William James, only in the past twenty or so years, with the emergence of cognitive psychology, has the complex nature of automaticity been explored in much depth (Crocker, 1984). Brown (1980) provides quite convincing evidence that the entire knowledge system could operate at a subconscious level. Extending the notion of subliminal percepton she concludes, "one can deduce that the unconscious perceptual apparatus of man is not only capable of accurately understanding the meaning of information, but some unconscious intelligence must also be able to make logical, meaningful associations with quite relevant memories, then activate exactly those brain nerve networks or mental processes that are appropriate to respond to what is perceived without any conscious awareness" (p. 67). Ceratinly one only needs to just barely begin to count the number of complex actions which a human being engages in through the course of a day to realize that much of what occurs to allow smooth functioning takes place at a subconscious level. It is important to note here, however, that any "subconscious intelligence" must be dependent on an extensive knowledge base. A base which is built, at least partially (if not primarily), through conscious means.

Much of the work relating to subconscious and conscious processing has been done under the guise af attention theory and has led to a division between automatic and controlled behavior. This division, however, should only represent two polar extremes of a continuum. With the background framework presented of a circular, interactive, multi-level knowledge system it would be rather naive to claim that any particular behavior could be brought about completely by either conscious or subconscious processes alone. With regard to this *automation-attention dichotomy* , Stelmach and Hughes (1983), refering to their perception of the work of Navon and Gopher (1979), Norman and Shallice (1980), and Fowler and Turvey (1978), in addition to their own work, comment in their concluding statements that "it appears that no act, in total, can be considered automatic; at some point they all seem to require (at least) either awareness [consciousness] or some form of control" (p. 87). However this does not mean that the *why* and *how* of behavior can always be reported. "We can do things that we do and do not know about, and conversely we can know things that we can and cannot do" (Newell and Barclay, 1982, p. 175). This performance analysis predicament results from the fact that "we do not attend to the same informaton when we describe our behavior as when we execute it" (Neisser, 1976, p. 97). It is this observation that is surely at the heart of the many difficulties which exist with theories of attention. As such, Wall et al.'s (1985) claim that notions of attentional control "might better be called the conscious control of action" (p. 33) will be adopted here. The notion of subconscious control of action will be added and the applicable knowledge which has been generated through attention research will be integrated into the interactive system of conscious and subconscious control of action under the new label of **context control.** (Context control will be elaborated on in the discussion chapter).

To be consious of something is to be *thinking* about it. Commenting on the conscious, thinking process, Whitney (1975) states:

> The normal human mind often acts in terms of problem situations. If these are familiar and their solution is well known and accepted, the individual reacts without thought, in terms of neural paths already established. This is tradition or habit. At each advance of life's experience, this body of settled, habitual, unthinking possibilities is added to until, in many realms of living, activity is smooth and continuous without the halt and reflect of the problem situation. ... Each situation in the normal individual has its pattern of response, once a matter of problem solving more or less complex, now devoid of any degree of reflection, until some new element is injected" (pp. 2-3).

Bruner (1983) sums up the situation most succinctly, "problem solving is for *kinky* cases that don't fit" (p. 129). This notion eventually leads to the realization, if one accepts the view, that the primary function of conscious processing is to allow the system, as a whole, to continually get to a higher and higher level of automation. In addition to this, however, consciousness also has an immediate function of directing the construction of moment to moment "models in our head". Specifically, consciousness comes into play when there is a need to define the context more clearly, when knowledge must be integrated into an action sequence, or when one wishes to reflect on one's *self* that has emerged through learning and development.

Conscious processing provides each individual with an element of control over the way in which *new elements* get injected into the system. "Erwin Schrodinger, in his essay 'Mind and Matter', calls consciousness 'the tutor who supervises the education of the living substance'" (Harth, 1982, p. 202). There is a cost, however, to this "tutoring". "Ironically, during certain phases of motor skill acquisition, the price of learning is a decrease in the overall performance of the skill until the new parts of the action have become automatized" (Wall et al., 1985, p. 34). Kinsbourne, from his research on "cerebral functional distance", would describe the reason for this initial reduction in performance level as being a result of structural interference caused by a spread of neural activation created as a consequence of conscious problem solving activity. In other words, as a consequence of learning.

This notion of consciousness as a "tutor" without direct influence on action parallels Wall et al.'s (1985) notion that action is instantiated by automatized procedural knowledge (p. 29). In Wall et al.'s knowledge base system the use of metacognitive knowledge (metacognition) is the conscious activity that allows a person to learn in problem solving situations (p. 32). New information relevant to declarative and affective knowledge is integrated into the existing knowledge base and with practice more and more parts of the action or action sequence which corresponds with the specific schema networks affected will become proceduralized. Even the schema network directing conscious reorganizing activity will become automatic after repeated use. This *higher level* of procedural knowledge is "metacognitive skill" (Wall et al., 1985, p. 32). The existence of metacognitive skills could account for the apparent human capacity to learn at a subconscious level, by revising, reorganizing, and re-interpreting what has been learned previously. As previously stated, however, it could not be unhesitantly concluded that knowledge acquired subconsciously was not influenced at some level in the sytem by conscious activity, such as in the formation of a goal or intention. On the other hand, it would appear equally dangerous to argue that no new relationships between inputs can be acquired without awareness. People often experience a problem and leave it unsolved only to have the answer *pop up* out of the subconscious where it was apparently solved. In this, Wall et al. seem to contradict themselves when they state "we agree with Baars, that 'there is little or no evidence that we can acquire new relationships between inputs without awareness'" (p. 35). Springer and Deutch (1985) provide the example of Otto Loewi's discovery of synaptic chemical transmission which apparently came about by a subconscious, chance connection of ideas. "The act of connecting two critical ideas apparently came while he was in an unconscious or semiconscious state. However the background for it had been set by years of rigourous [primarily conscious] work" (p. 195). Clearly occasions for both conscious and subconscious processing; for controlled and automatic responding, exist in every context created. As long as the brain is functioning and problem solving is occurring some amount of conscious activity will exist. And if a person is aware of any particular input impinging on the system they cannot also be, simultaneously, conscious of all the other necessary inputs which are required to allow the system to function as a whole. An understanding of how the system operates in terms of shifting the balance along the conscious-subconscious continuum can provide valuable knowledge of how learning and performance can be enhanced. "It is the polarity and integration" say Ornstein (1972), "of these two modes of consciousness, the complementary workings of the intellect and the intuitive which underlie our highest achievements" (p. 80).

To conclude this section, an example of the operation of this shifting balance of conscious-subconscious activity might best serve to acknowledge the significance of this working feature.

The ideas for this critical inquiry arose out of a lifetime of experiences, no doubt, but particularly out of knowledge acquired over the last four years of academic study. Reflecting on what had been learned, the formation of a model based on the intention of organizing an extensive number of psychological reports about learning and performance so that they might be understood in a relational way, seemed a logical way to proceed. As the process began many *hunches* were jotted down and gradually worked into a general framework. At the conclusion of the first model it seemed to have much intuitive appeal. This was natural because it was based almost totally on intuition; the connections felt right. Then began the important cognitive procedure of explicitly detailing the proposed features. The source of these hunches had to be retraced. While the whole process has been somewhat laborious, it reinforced the value of conscious, intellectual, analytical processing. Much of the first model contained erroneous assumptions. The model presented in figure 2 is the outcome of many preliminary drafts and will assuredly not be the final one. However, it is presently the most complete form possible based on the author's knowledge base capacity at this time. Although each of the intuitive ideas have not been unmistakably verified, it is not rational to believe that they could be. Hoff (1982), in The Tao of Pooh (as in Winnie the Pooh) explains: "Let's say you get an idea - or as Pooh would more accurately say, it gets you - where did it come from? From this something, which came from that something? If you are able to trace it all the way back to its source, you will discover that it came from Nothing" (p. 150).

It is evident that not all of one's knowledge base is verbally accessable. To truly integrate all of one's individual knowledge which exists at any point in time both intellect and intuition must be utilized. Carl Sagan (1979) concludes "perceptions may be distorted by training and prejudice or merely because of limitations of our sense organs, which of course perceive directly but a small fraction of the phenomenon of the world. [Thus] our intuition is by no means an infallible guide" (p. 13).

The critical balance between conscious and subconscious activity is evident in the feeling that is shaped by the descriptive ancient Taoist maxim, "the wise are not learned, the learned not wise" (Hoff, 1982, p. 24).

G. Response Modes

The functioning of the knowledge base system is recognized to proceed along three modes of operation. When input patterns perceived match those that are expected, activity flowing through the system remains at a subconscious level and the actions that are generated by this activity are *automated* responses. However, any imbalance in the system activates consciousness and conflict resolution processes are engaged in through either a *guided* response or a *reflective* response. Thus three types of responses to the flow of activity through the system can occur: (1) Raw sense data can flow through the entire system subconsciously while automatically triggering well learned processing; (2) Raw sense data can be combined with analyzed data and thus guide activity so as to create new sense data; and (3) Previously analyzed data can be re-analyzed (reorganized) without causing immediate action response activity. How such operations might occur can be seen in an adapted version of Harth's (1982) simple conceptual model of the nervous system as shown in figure 7.

In this model three different pathways that distinguish the three response modes are indicated. Input arrives at the sensory cortex from the outside world and from other areas of the cerbral cortex. If these inputs do not conflict then the flow of activity continues unobstructed through the system and an automatized response is executed. If however some form of conflict between activated schema exists from either physcial or attentional constraints of the action being called for (Norman and Shallice, 1980), a delay in processing results. This delay is a result of conscious activity which functions, in part, to activate "corticofugal" pathways that serve to either open some relays or close others in order to add strength to one of the conflicting schema networks over the other (or activate entire new ones). Information from both external and proprioceptive feedback is utilized.

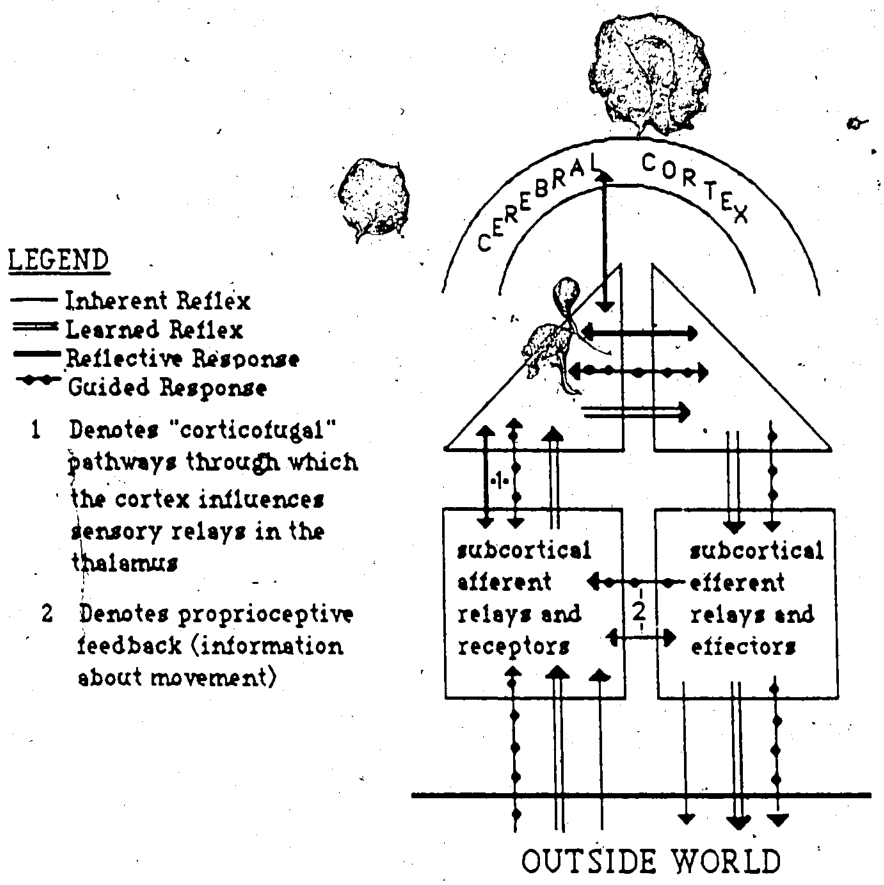

Figure 7 - Simple conceptual model of the nervous system reflecting possible structural pathways through which the three response cycles may be seen to operate (Adapted from Harth, 1982, p. 171).

The automated and guided response modes might be considered to be the operations that occur *within a task* and the reflective response mode can best be described as the operation that occurs *between tasks*. The function of the reflective response can be related to the formation of "cognitive maps" and "action plans", and to the notion of "priming". Gallistel (1981) states that "the higher levels [such as the conscious reflective response] lay down a frame or general description for behavior by selectively potentiating coherent sets of behavioral options" (p. 8).

The three response modes seem to work very well together. Automatic response execution ensures that some amount of new informaton will always be available to the system. The instant movement or thinking occurs, the context has been altered to some degree. The guided response mode then responds selectively (directed towards intended goals) to the new information presented and activates functions which allow that information to be held long enough to *try things out* so as to cause some effect on the knowledge base. The situation is reflected in Newell and Barclay's (1982) statement that "the person knows, although not in these terms, that an instantiated schema is needed even if he has no idea as to an appropriate solution or plan to be used" (p. 188). The consistent repetition of new information arriving at the knowledge base then causes some reorganization and results in the ability to *conjure up* new thoughts which then reflect back on the context and cause further mismatches within the system. This cyclic nature is what propels learning and development. Debono (1969) describes three basic types of problems which have clear parallels to the three response modes proposed. He describes these problems as:

> 1. Problems that require the processing of available information or the collection of more information [guided response].
>
> 2. The problem of no problem, where the acceptance of an adequate state of affairs precludes consideration of a change to a better state [automated response].

3. Problems that are solved by a re-structuring of the information that has already been processed into a pattern [reflective response].

Although the above descriptions are speculative, they demonstrate a reasonable degree of consistency with present views of schema, Norman and Shallice's (1980) model, physiological evidence (as provided by Harth, 1982), and with Wall et al.'s (1985) views on knowledge and the conscious control of action.

DISCUSSION

The Value of Critical Inquiry

The discussion section of a major paper is the place where it is appropriate to ask, *so what?* The preceding exploration of the literature has presented a panorama of selected [illegible]s, views and reflections, and a learning and performance model has been synthesized from this montage. However no pretense of having presented a complete picture of human performance has been made. So what value does this critical philosophical inquiry have?

"Information is the speciality of our age" (Harth, 1982, p. 229). The value of creating a model is that it provides a background against which learning and performance information from multiple sources and orientations can be evaluated and integrated, and then more completely understood. "With understanding goes the power to manipulate, to control, and ultimately, to create" (Harth, 1982, p. 228). In order to demonstrate the value of this process and to more completely depict the interactions of the various features of the model a specific example of an *understanding* that has emerged from the synthesis of the model is discussed forthwith.

Nideffer (1976) wrote "it is hard to imagine a variable more central to performance than the ability to direct and control one's attention" (p. 395). Inconsistent theories of attention have, however, led to conceptual confusion more often than they have provided any kind of enlightened orientation to performance. Perhaps this is the reason that Wall et al. (1985) suggest that "attentional control" might better be called the "conscious control of action". Neisser's (1976) comments regarding the dissolution of attention theory are even more forceful. He states "attention is nothing but perception: We choose what we will see by anticipating the structured information it will provide" (p. 87). One source of the confusion surrounding attention theory is that (at least) two distinct conceptualizations are apparent in the performance literature. As Ries and Bird (1982) point out, these two divergent viewpoints are generally associated with cognitive versus clinical psychological divisions. "From the information processing or experimental viewpoint, attention is said to be the process that actively selects the inputs to, operations in, and responses from the central operating space, thereby determining the direction of behavior" (p. 64). Here attention is viewed from a mechanistic position. On the contrary, clinical or "differential" psychology, views attention more as a "personality trait or individual difference variable" and gives rise to the notion of characteristic "styles of attending to stimuli" (Klein, 1979, p. 64) such as has been popularized by the work of Nideffer.

Both views contain aspects of truth. However, in a very general way, this division seems reminiscent of Democritus' description of the battle between the intellect and the senses (as cited previously). In the performance model presented here (figure 2), *context* is the working feature that unites internal and external worlds. As such, an expansion of the concept of attentional control, or conscious control, to **context control** may be a useful addition in an effort to more ompletely understand human performance.

Action is a result of the organism-environment interaction; the knowledge base interacting with the external stimuli, determined by the nature of the task and the environmental setting. Behavior isn't influenced by actively *picking up* certain internal or external cues, but rather a context is continually constructed from the interaction of these cues over time resulting in the activation of some schemas and not others. The *meaning* of cues is always relational. Thus, it is hard to imagine a variable more central to learning and performance than the ability to influence the construction or maintenance of appropriate contexts. Indeed, the ability to somehow create contexts which allow best performances seems to be a characteristic that many top performers have developed. "According to the data collected, highly successful competitors have achieved substantial control over the psychological climate that is associated with their best performances" (Loehr, 1983, p. 3). Most notably, it also seems apparent that the control these competitors have achieved is not entirely a result of enhanced conscious states. If the control was entirely conscious, and thus relatively easy to verbalize, performance variability would certainly be much less than it is. *Context control* does not have the same dominating consciousness overtones as does attentional control theory. As such, while the value of conscious control must not be down played, this orientation allows the power of subconscious control to be equally recognized.

Context Control

The concept of context control is a consequence of the knowledge that has been acquired from putting this thesis together and has given rise to the conceptualization of a performance enhancement program revolving around the notion of directing the formation of appropriate situational contexts. While the specifics of this program are still in an infant stage of development, and have not yet been scientifically applied, a brief discussion of its preliminary conceptual features will demonstrate with more clarity the implications, and at least one potential application, of the model.

The major goal of context control is to consistently create organism-environment interaction situations which are optimal for achieving desired goals. Three general situations, *learning* , *learning to perform* , and *performing* are recognized in this framework. The context required for effectively dealing with the acquistion of novel tasks, or the application of old skills under new conditions, is fundamentally different from that required for any given *performance* , where skill acquistion is no longer the goal, but rather, skill execution is. Performance requires quick selection and run-off of well established patterns. The goal during a *learning* situation should be to develop more **sufficient** actions (or thoughts), while *learning to perform* involves making learned actions more **efficient**. Finally, the *performance* situation has **proficiency** of action and thought as its goal.

The distinction of three general situations is reflected in the model by the three response cycles. Although any observable response will always be a function of the interaction and integration of all three modes, the three general situations presented are reflected in the dominance of one mode over the other two. Learning can be viewed as operating principally within the reflective cycle, learning to perform to the guided response mode, and performing to the automated mode.

Since no complete action, through all phases of the perception-decision-response cycle can be considered to be totally subconscious, nor can any action be brought about entirely through conscious means, what is critical for maximizing learning and performance opportunities is the creation of contexts that tune the system to an appropriate balance, for the specific situation at hand, along a conscious-subconscious continuum.

In performance situations numerous reports from athletes regarding their best performances suggest that the balancing of the subconscious-conscious scale should definitely be tipped towards the subconscious end. In a study attempting to determine the makeup of ideal performance states, Loehr(1983) asked a variety of athletes to describe what their "internal psychological experience" was like during their best performances. The responses were extremely consistent. Responses like; "Everything seemed to flow automatically"; "I didn't really have to think about what I was supposed to do"; and "It just seemed to happen naturally", were the norm. And while it became a running joke among team mates of an elite level women's volleyball team a few years ago, their intuitively accurate expression "don't think - it hurts the team" became a standard line following performance errors. The squelching of over thinking is a decisive variable in the establishment of ideal *performance* states, where the run-off of automatic actions is essential. "The main purpose of thinking is to abolish thinking" says Debono (1971, p. 37), and it is exactly the abolishing of over thinking that these women were intuitively alluding to.

Learning how to perform, which is to say, how to make learned actions increasingly efficient until they are proficient, or how to shift processing activity towards the subconscious end of the continuum, requires learning how to consciously observe the operations of the subconscious without interference. Schneider and Fisk (1983) claim, based on their research, that "performers must learn to allow automatic productions to be executed without direct control or the use of limited resources" (p. 132). How then might this control be developed?

The ability to control the placement of conscious and subconscious involvement along the continuum is a function of the development of the knowledge base. "Our basic premise", say Wall et al. (1985), "is that the development of declarative, procedural, affective, and metacognitive knowledge about action allows for the more accurate use of voluntary attentional control in the acquisition of skilled action" (p. 33). As metacognitive knowledge increases, the ability to see more clearly the interaciton effects between the person, task and environment will most assuredly help learners and performers set appropriate situational contexts.

> Through time and experience, the individual comes to intimately understand his/her physical reality, the reality of the surrounding world, and how that world relates to his/her movement. With this understanding the individual can **predict** the effects of contraints prior to moving and thus **plan** an appropriate movement (Arend, 1980, cited in Wall et al., 1985, p. 36).

As one continues to learn and the knowledge base expands "deliberate conscious control of action will become more accurate and efficient in a broader array of situations" (Wall et al., 1985, p. 36). This is why, for example, it is crucial for teachers (coaches), in learning situations, to tell their students (athletes) **why** they are doing things, as opposed to operating with a command style of communication. Interestingly, the reverse may be true for performance situations because of the need to shift towards the subconscious operating side of the continuum.

Wall et al.'s (1985) ideas about the conscious control of action form a partial base for the concept of context control but they do not go far enough. In particular, they do not adequately incorporate the influence of the affective knowledge (and intuition) into their control system. In fairness to these researchers, however, the context in which they were discussing their ideas was one principally associated with learning and development. It did not include aspects of the performance situation, and it is really only in this context that the significance of subconscious control dominantly emerges. This is not to say, however, that subconscious activity is not a critical feature withing the learning system.

The very act of attempting to *think* about a form of subconscious control creates an interesting paradox. How does one explain a control feature that operates beneath awareness? Any answer will assuredly appear vague and not well-founded - *such is the nature of this feature.* However, one of the best attempts at describing this phenomenon is provided by Gendlin (1978) in his concept of a "felt sense". To avoid getting trapped in an analytical, completely conscious operation, that might prevent the establishing of a context that would allow this idea of a "felt sense" to be perceived, examples (which creat *images*) of this concept will be given rather than a detailed verbal description.

> If you observe a golfer getting ready to swing, you can see the whole body taking aim. It's done not just with the eyes or the arms but by changing the placement of the feet, rotating and repositioning the whole body. Golfers aim with the feel of the whole body. ... Or, suppose you have been listening to to a discussion and are about to say something relevant and important. The others are still talking. You don't have your words prepared. All you have is a felt sense of what you want to say (Gendlin, 1978, p. 85).

A positive felt sense is what performers strive for (although they may not refer to it in this way) and when they get it they usually can't describe how it came about or even what exactly it is, primarily because most of it was developed beneath conscious awareness. A felt sense is the end result of effective conscientious learning that reflects the belief that "the function of thought is to eliminate itself and allow action to follow directly on recognition of a situation" (Debono, 1969, p. 24). But the recognition does not result from the specific operation of the declarative/metacognitive knowledge domain, instead it is a momentary appreciation of the operation of the affective/intuitive knowledge domain, which is assumed to be "right brain oriented" and thus largely non-verbal.

With regard to processing functions within the human brain, experiencing a felt sense may well represent a situation in which a person is momentarily conscious, but non-judgemental, of subconscious control. Such a situation arises when one encounters "the kind of task where a single spatial image processed as a whole proves more effective than a detailed verbal or mathematical description" and typifies right hemisphere activity, which is very proficient at processing items as wholes (Fishburne, 1984, p. 20).

Adjusting the flow of activity along a conscious-subconscious continuum is the decisive operation of "context control". It reflects a concern for striking a balance between intuitive and logical thought. In a learning situation the balance is shifted towards conscious cognitive operations. In performance situations the performer must learn how to consciously set a context that will allow subconscious, feeling state, control to take over. They must develop an appreciation for their intuitive feelings and then learn to trust them. The recent surge in mental rehearsal, image-generating, strategies reported in performance literature is as strong a statement as any regarding the importance of uniting conscious and subconscious control variables. A good deal of new information about techniques and strategies for developing "whole brain" operation (Fishburne,

1984) should prove to be extremely valuable in establishing methods for adjusting the context control gate.

A Macroscopic Working Example

The formalization of this thesis has resulted from visual information (written records of numerous researchers) that has been integrated with the author's own previous thoughts and feelings. This led to the conceptualization and diagramming of a learning and performance model through which the goal of more fully realizing ways to advance human potential (change potential into reality) has resulted in the conceptualization of a *context control* training program. Throughout the inquiry a context was created, in fact a set of contexts within contexts that led to multiple intentions, was developed. Some of these intentions were carried out procedurally. Without such automated skills as those that allow the author to get these notes down on paper and the metacognitive skills and strategies that guide the search for interactions, it would not have been possible to procede. Along with each intention, the corresponding expectations have been compared against the informational material that has been perceived and where conflicts or some degree of mismatch was apparent a conscious search and integration of informational sources (knowledge base and environment) led to at least a temporary solving of the pro[illegible]. When expectations and perceptions matched they momentarily [illegible] taken as truth, or reality, and it is this present reality that is noted in the form of this thesis. New information will of course be perceived in the future that raises new problems, and as well, new information will further reinforce some of what is written here. The key point is that right now it feels right and the dynamically stable base that it provides allows one to *get on with it* ; to test new information against a relatively well integrated and organized framework. Consequently, learning is made more efficient leading ultimately to enhanced performance.

Through this type of comparative process a dynamic interaction effect between intuitive feelings and verbal expression exists. The ideas which present themselves from time to time are at first vague and ill-defined. They are largely intuitive. By consciously attempting to work out the details of these felt ideas, they gradually become clearer. Occassionally this clarity reveals that the intuition was accurate and useful. Most often however, the ideas must be slightly adjusted by incorporating other ideas. Or sometimes they are disregarded altogether, often, interestingly enough, only to reappear at a later time where they may fit quite nicely.

> There is no way to tell whether patterns extracted by the right hemisphere are real or imagined without subjecting them to left hemisphere scrutiny. On the other hand mere critical thinking, without creative and intuitive insights, without the search for new patterns, is sterile and doomed. To solve complex problems in changing circumstances requires the activity of both cerebral hemispheres: The path to the future lies through the corpus callosum (Carl Sagan, cited in Springer and Duetsch, 1985, p. 192).

A Broader Developmental Perspective

The efficiency of the organizational network for acquired knowledge is a crucial feature of development. Development may be viewed as the transformation of potential into reality. It is a process of continuous refinement by which raw materials are transformed into an enhanced state. The concept of context control will follow this process of refinement and enhancement, and as long as the goal to do so is maintained the system will function to bring this about.

Specifically, the primary goal is reflected in the need to integrate conscious and subconscious control variables through the development of a "holonistic" approach to learning and performance. The concept of context control subserves this purpose (at least temporarily) quite adequately. But context control is more than just a psychological skill training program, it has implications for an entire physical education and sports developmental program. Throughout one's life an interaction of learning and performing is never-ending and the level of wisdom that is attained is determined by the effectiveness of learning how to perform. In other words, pushing learned skills beyond the level of necessary conscious intervention is required in order to allow room for new skills (knowledge) to develop. Significant attention needs to be given to the nature of context effects and their influence on the life long knowledge acquisition process for optimal development, in any field of endeavor, to occur.

Learning and Performance Summary Notes

To conclude this discussion chapter a number of quotations and relevant thoughts about learning and performance and noted. An obvious interaction between learning and performance exists which is expressed through the circularity of the model presented. The human, knowledge based system is "built for learning", but it is also equally true that it is built for performing as well. Learning and performing are inextricably related phenomena which are at the heart of development. In fact, they often merge into the same process. For example, the infant cries and wins attention, or the young boy watches others at his first banquet and sees which fork to use. "One trial learning" situations are examples of learning and performance merging. The summaries which follow reflect this notion and, as well, reinforce some of the essential features of each situation.

A. Learning

1. Learning is based on knowledge. "People continually try to understand and think about the new in terms of what they already know. ... Abilities to make inferences and to generate new information can be fostered by insuring maximum contact with prior knowledge that can be restructured and further developed" (Glaser, 1984, pp. 100-101). Thus, when *teaching* it might be best to help

the learner first learn what aspects of the new task are similar to previous tasks, and the acquired skills associated with successful completion of them, and then allow him/her to go beyond that on his/her own. The goal of the teacher here should be to assist the student in recalling appropriate contexts which allow them to integrate new information, rather than simply *forcing* this information on them.

2. "Effective thinking is the result of 'conditionalized' knowledge - knowledge associated with the conditions and constraints of its use. As this knowledge is used and transferred to domains of related knowledge, the skills involved probably then become more generalized so that intelligent performance is displayed in the context of novel ('nonentrenched') situations (Sternberg, 1981, cited in Glaser, 1984, p. 99).

3. "It seems that knowledge of task characteristics is acquired through two sources: (a) Actual experiences on the specific task, and/or (b) generalized (constructed) knowledge from experience on a class of tasks with similiar characteristics" (Newell and Barclay, 1982, p. 189).

4. "More than any other factor, thoughts are the foundation of normal consciousness. We maintain and refresh our personal constructs through continual thoughts" (Ornstein, 1972, p. 54).

5. "Fowler and Turvey (1978) essentially maintain that skill learning represents the control of numerous action subsystems to the point where perhaps only the **intent** to achieve a goal is sufficient at any high level of the control system, the details of specification, subject as they are to peculiar context contingencies, are left to lower

levels" (Stelmach and Hughes, 1983, p. 86).

6. "The uniqueness of human beings is represented by the capacity to do something for the first time" (Cousins, 1981, p. 21). Although this may not be truely unique, since many "higher" animals seem to be quite good at this as well, the intent of the message should not be lost. Certainly the *complexity* of what humans can do for the first time is most astounding.

B. Performance

1. Intuition "is a synthetic function in the sense that it apprehends the totality of a given situation or psychological reality. It does not work form part to whole - as the analytical mind does, but apprehends a totality directly in its living existence" (Assagiolo, cited in Ornstein, 1972, p. 85). The *totality* apprehended is often incomplete and inaccurate in the initial stage but it is a totality as opposed to detail. A small boy kicking a soccer ball while talking aloud and at times shouting excitedly, tells you he is "playing the *Grey Cup (?)* game" - all of it. He is both teams, the referee, the crowd, and the TV camera and anouncer, all at once.

2. "Studies on habituation suggest that we tune out the recurrences of the world by making a *model* of the external world within our nervous system, and testing input against it. We somehow can program, and continually revise or reprogram, our models of the external world. If the input and the model agree, as

they do most often for the constancies of the world, then the input stays out of consciousness. If there is any disagreement, if the new input is recognizably different, slower, softer, louder, different in form or color, *or even absent* , we become aware of the input once again" (Ornstein, 1972, p. 47).

3. "Much of our everyday motor activity belies explicit accounts of its construction, leaving, as often as not, the intention and goal as the only aspects of action which can be articulated" (Newell and Barclay, 1982, p. 183). The significance of *goal setting* , which is the process of "specifying intentions", is that it is at least one of the means by which subconscious activity can be conscously directly. "Your built-in success mechanism must have a goal or 'target'. ... The automatic mechanism is teleological, that is, operates, or must be oriented to 'end results', goals" (Maltz, 1960, p. 28). In learning, the goal is to attend to the **process**. In performing, the goal is the end **product**.

4. "Perhaps the truly great world class athlete [or any performer] is one who can develop both the narrow focused attentional skills requisite to learning and refinement of physical skills and the open focus attentional states associated with optimization of performance. ... Open focus, which permits the release and diffusion of learned experience into an expanded field of awareness, is a self regulation strategy. ... [It is] intuitive attentional processing [and] facilitates the ascendancy of right hemispheric information processing [so that] the usually dominant left hemispheric processes can now be integrated with this gestalt orientation of right hemispheric processes" (Fehmi and Fritz, 1980, p.

28).

5. "Accelerating conscious control of the ideal emotional climate should result in improved competitive performance" (Loehr, 1983, p. 17). This acceleration, says Loehr, can be accomplished through a three part learning program: (a) *Awareness training* ; which increases an athlete's awareness and understanding of the specific elements of an ideal climate for competition. Loehr has designed a rating scale to be used immediately following performance to promote this; (b) *Emotional rehearsal training* ; which is mental rehearsl of emotional climates asociated with best performances - visualizing one's *finest hour* ; and (c) *Match training strategies to ideal performance state deficiencies* ; a variety of training strategies can be used depending on the specific deficiency. They may be associated with problems of relaxation - where biofeedback, autosuggestion training, or progressive relaxation, for example, may be of benefit; with motivation - where problems with confidence and competence, self-esteem, need for approval or perceived control might be influencing factors; or with concentration - where focusing techniques such as Nideffer's ACT (attention control training) program, Fehmi's "Open Focus" techniques, or simply awarenss of the importance of self talk, may be beneficial.

CONCLUSION

Borrowing Toffler's (1980) description, the present learning and performance situation was depicted in the introduction as a "swirling phantasmagoria" (swirling changes of a scene made up of many elements, where ~~it is~~ often difficult to separate reality from illusion). Preliminary thoughts of reducing the elements, of slowing the pace of change or reducing the number of changes, in retrospect, were part of the illusion. As many unanswered questions exist now as at the beginning, due, at least in part, to the fact that many changes occurred throughout this communication process - such is the progress of development. This is the nature of a circular system "built for learning". However, to the degree that recurring patterns and relationships within and among swirls are coming into focus, the project has been successful - even if it ultimately only proves to be a momentary pause.

To impel development, to reach for wisdom, and to expound human potential have been the (perhaps somewhat visionary, but none the less worthwhile) goals that have provided the directional force for this critical inquiry. Thus the presentation of the following three quotations regarding these concerns feels like an appropriate summation:

> Human beings, whatever their age, are completed forms of what they are, just as societies are completed forms of what they are. Growing is becoming different, not better or faster (Bruner, 1983, p. 131).

There is a tendency to mistake data for wisdom, just as there [illegible]lways been a tendency to confuse [illegible] with values, intelligence with insight. [illegible]obstructed access to facts can produce unlimited good only if it is ~~matched~~ by the desire and ability to find out what they mean and where they lead. Facts are terrible things if left sprawling and unattended. They are too easily regarded as evaluated certainties rather than as the rawest of raw materials crying to be processed into the texture of logic (Cousins, 1981, p. 104).

The human species is unique because it alone can create, recognize, and exercise options. This means it can do things for the first time. We can reasonably argue, therefore, that human beings are equal to their needs, that a problem can be resolved if it can be perceived, that progress is what is left over after the seemingly impossible has been retired, and that the crisis today in human affairs is represented not by the absence of human capacity, but by the failure to recognize that the capacity exists (Cousins, 1981, p. 46).

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