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Between neuron, culture and logic: explicating the cognitive nexus
Neurones, culture et logique: vers une connexion cognitive

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Abstract: The paradigm shift from behaviorism to cognitive science has wrought many changes in our methodologies, experimental techniques, and models of human activity. Not the least of these changes has been the legitimation of such hidden variables as *mental processes.* The cognitive science paradigm has been a swift river carrying us to new horizons but there are now a number of major counter-currents. The positivism of behaviorism is being replaced by the reductionism of neural networks—how do mental processes arise out of physical cellular activity? The ontogenetic bias of both behaviorism and cognitive science is being challenged by ethnomethodological perspectives in which the very notion of an *individual* is an experimental artifact—how do mental processes arise out of the lifeworld? Meanwhile the promise of greater understanding of the *knowledge level* is being fulfilled, and operational models of human cognition and action are being generated—how do mental processes relate to the logical structures of overt knowledge? This paper surveys these issues both theoretically and in terms of practical applications. It suggests that it is from the underlying tensions that the strength of the cognitive science paradigm arises, but to harness that strength requires much broader concepts of cognition and mental processes than are conventionally accepted.

Résumé: Le déplacement du paradigme du béhaviorisme vers celui des sciences cognitives a suscité de nombreux changements dans notre méthodologie, nos techniques expérimentales et nos modèles du comportement humain: en particulier, la légitimation de ces variables cachées que sont les *processus mentaux*. Le paradigme des sciences cognitives est un fleuve rapide qui nous transporte vers d'autres horizons où cependant se dessinent plusieurs contre-courants majeurs. Le positivisme du béhaviorisme est remplacé par le réductionnisme des réseaux neuromimétiques—comment les processus mentaux sont-ils issus de l'activité physique cellulaire? La perspective ontogénétique commune au béhaviorisme et aux sciences cognitives est disputée par la perspective ethnométhodologique selon laquelle la notion meme d'*individu* devient un artefact expérimental—comment les processus mentaux sont-ils issus du monde vivant? Pendant ce temps, les promesses d'une plus grande maitrise du *niveau de la connaissance* se réalisent—comment les processus mentaux sont-ils reliés la structure logique de la connaissance explicite? Cet article effectue un survol de cette problématique la fois du point de vue théorique et du point de vue des applications. Nous émettons l'hypothèse que ce sont les tensions sous-jacentes au paradigme des sciences cognitives qui en font la force, mais que la canalisation de cette force exige un élargissement au-de des définitions traditionnelles des concepts de cognition et de processus mentaux.

"Cognitive science is the study of intelligence and intelligent systems,
with particular reference to intelligent behavior as computation."
(Simon & Kaplan, 1989)

"Cognition—the act or process of knowing; perception."
"Intelligence—capacity for reasoning, understanding, and for similar forms of mental activity; aptitude in grasping truths, facts, meanings, etc."
"Mind—(in a human or other conscious being) the element, part, substance, or process that reasons, thinks, wills, perceives, judges, etc."
"Meaning—the end, purpose or significance of something."
(Webster's Dictionary)

Introduction

There is much excitement about cognitive science and many books are appearing recounting the history of the rise of cognitive science (Baars, 1986; Hirst, 1988; Meyering, 1989) and the demise of behaviorism (Mackenzie, 1977; Zuriff, 1985; Smith, 1986; Morawski, 1988; Buckley, 1989). What is this cognitive science about whose triumph we are all so proud? The quote above from Simon and Kaplan's opening to Posner's massive *Introduction to Cognitive Science* captures the common stereotype of cognitive science—intelligent systems within a computational ethos. The dictionary definitions below it remind us that notions of cognition, intelligence, mind and meaning are part of colloquial culture and that we should be aware of gaps between our technical uses of these terms and our everyday preconceptions of what they represent. Two features of these definitions may be noted: the ambiguity over mind as 'element, part, substance or process'—paralleling philosophical difficulties in explicating the phenomena of mind; and the lack of notions of information processing or computation in our colloquial definitions—these are part of our technical infrastructure, of 'scientific explanation.'

There are some who see the emphasis on behavior as computation as a severe distortion of the frame of reference of cognitive science, that the legitimation of the concept of the human mind and its imposition of meaning upon the world has been replaced with a neo-behaviorist emphasis on mindless information processing. Bruner, widely recognized as a major founder of cognitive science, has commented:

> "Very early on, for example, emphasis began shifting from 'meaning' to 'information,' from the *construction* of meaning to the *processing* of information. These are profoundly different matters." (Bruner, 1990)

Johnson-Laird and Wason take an opposing point of view:

> "A revolution occurred in the 1950s which might crudely be summarized as the overthrow of Behaviourism by Information Processing." (Johnson-Laird & Wason, 1977)

There appears to be a very profound difference in viewpoint as to the nature of cognitive science expressed in these two quotations. Have we not just replaced one flavor of behaviorism by another? Are we really willing to take the mind and its imposition of meaning as serious constructs? Can the two viewpoints be reconciled?

Searle sees the distinction that Bruner makes as absolute—meaning cannot arise out of mechanism. His argument can be summarized in one quotation:

> "programs are purely formally specifiable—that is, they have no semantic content." (Searle, 1984, p.33)

This captures one significant dimension of the problems of cognition, reasoning and knowledge, the relation between logic and psychology, the essence of the Frege-Husserl debate in the 1890s (Mohanty, 1982) that led to the paradigms of formal logic on the one hand and phenomenology on the other. In the 1960s phenomenology was seen as the providing the ethos which could counterbalance the excesses of behaviorism (Wann, 1964). By the late 1980s some were already looking back to Husserl and later phenomenologists such as Merleau-Ponty to counterbalance excesses of cognitivism (Costall & Still, 1987).

It is doubtful that Searle's rather dry philosophical analysis in terms of a syntax-semantics dimension captures more than a small part of Bruner's *cri de coeur*. There are humanistic and cultural dimensions to the notion of meaning that Husserl's successors such as Heidegger, Sartre, Marcuse and Derrida have developed in depth and which have become the essence of concept of a post modern ethos. It is interesting that texts on cognitive science inevitably pay lip-service to the significance of culture in cognition but then find precious little space to address the issues:

> "if the goal is no less than a verified architecture of cognition that can illuminate the full range of human intelligence, the distance yet to go is staggering. Two areas in which these distances are most notable are in the study of cultural differences in cognition and subjective mental experience and the brain." (Preface to Posner, 1989)

Maybe the strategy of looking where the light is brightest, rather than where the object is lost, is innate and unavoidable. However, there are some bright lights along the cultural dimension that have much to say about cognitive science. For example, Vanderburg's (1985) analysis of the growth of minds and cultures, and Heller's (1990) model of modernity, the self and society.

The second issue noted in the quote above, the mind-brain question, has been a major topic in philosophy since Descartes first introduced the underlying dualism. In the 1960s major advances were made in understanding the mechanisms and significance of inner regions of the brain, notably the limbic region and its role in attention, and it was hoped at that time that the digital computer and the simulation of neural networks would provide further insights into neurological functioning. However, it was not until the mid-1980s that improvements in the storage size, computing power and cost of computers made significant progress in brain simulation feasible, and we still have far to go. Currently, work on the philosophical issues raised by having almost within out grasp the potential to simulate large brain-like structures on a realistic basis, that is operationalizing theories of neural function, is more significant than any empirical results of such simulation.

Smolensky has been a major proponent of neural modeling not as a 'bottom-up' reductionist strategy of explicating the mind through its physical mechanism, but as a 'top-down' strategy of characterizing a task in a way that allows the mathematical *derivation* of mechanisms that perform it:

> "My claim is not that the strategy leads to descriptions that are necessarily applicable to all cognitive systems, but rather that the strategy leads to new insights, mathematical results, computer architectures, and computer models that fill in the relatively unexplored world of parallel, massively distributed systems that perform cognitive tasks. Filling in this conceptual world is a necessary subtask, I believe, for understanding how brains and minds are capable of intelligence and for assessing whether computers with novel architectures might share this capability." (Smolensky, 1986)

This argument is systemic, that function constrains form, and akin to that which Bertalanffy developed for the possibility of a general systems theory:

> "A certain objective is given; to find ways and means for its realization requires the systems specialist to consider alternative solutions and to choose those promising optimizations at maximum efficiency and minimal cost in a tremendously complex network of interactions." (Bertalanffy, 1968)

This systemic viewpoint has much greater philosophical force than the associated cybernetic viewpoint of Wiener (1948) which is closer to the cognition as information processing paradigm in emphasizing the analogy between animal and machine in terms of control and communication. The Smolensky/Bertalanffy argument would be that such an analogy arises because of common functions. A deeper argument still would be that these common functions arise out of the origins of machines in human culture—that technology arises out of and, initially at least, subserves society. Kohak captures this well in his remarks:

> "Technology is the human's achievement, not his failing—even though the use he chooses to make of it may be fallen indeed. If the products of human techne become philosophically and experientially problematic, it is, I would submit, because we come to think of them as autonomous of the purpose which led to their production and gives them meaning. We become, in effect, victims of self-forgetting, losing sight of the moral sense which is the justification of technology. Quite concretely, the purpose of electric light is to help humans to see. When it comes to blind them to the world around them it becomes counterproductive. The task thus is not to abolish technology but to see through it to the human meaning which justifies it and directs its use." (Kohak, 1984)

In the context of this paper, this counters any argument that the reduction of mind to mechanism is intrinsically dehumanizing by reminding us that mechanism arises out of mind and is a substructure of humanity.

The coupling of the Smolensky and Bertalanffy quotations draws attention to the hypothesized agency, the 'system specialist', generating Smolensky's assumed relation between function and form. At one level this might be evolutionary adaption with its presumed optimizing influence at the genetic level (Dupré, 1987). At another level it might be cultural adaption with its presumed optimizing influence at the programming level (Boyd & Richerson, 1985). Of course, the hypothesis of directedness, let alone agency, in these processes is itself problematic (Gould, 1989). From a systemic viewpoint the relations between cognition, neurology, genetics and culture are both strong and immediate, and raise deep philosophical issues.

What of knowledge? This introduction has come far, rather farther than intended, without mentioning it. Is not cognition the *act of knowing*, and is not what is known, clearly, *knowledge*? These are profound questions and ones to which there is no easy answer, except perhaps 'no.' Let us delay the answer with some quotes. Much has been written about knowledge but Gorgias of Leontini around 450 BC expressed a viewpoint which is timely today:

(1) Nothing exists;

(2) Even if something did exist it could not be known;

(3) Even if it were known this knowledge could not be communicated.

We can capture the essence of post modern ideologies by some slight extension:

(4) Even it it were communicated this communication could not be understood;

(5) Even if it were understood this understanding could not be utilized;

(6) Even if it were utilized this utilization could not be beneficial.

In cognitive science Schiffer's (1987) "no theory" theory of meaning and Stich's (1990) "no truth" account of cognition are outstanding examples of the sceptical paradigm. They illustrate that our cultural preconceptions of what we would like to be, what we think we should be, are carried over into science and blind us to the empirical evidence as to what we are and the systemic constraints on what we might be.

Newell's (1982) *knowledge level hypothesis* captured much of the ethos of artificial intelligence research which in its turn has permeated cognitive science. The knowledge level lies above the symbol or program level and characterizes the behavior of problem solving agents in terms of their goals and actions, with knowledge serving as the medium, on the basis of a simple principle of rationality that an agent will carry out an action if it has knowledge that one of its goals can be achieved by that action. This line of argument is itself part of the ethos of a much greater scenario for human civilization, the enlightenment vision of rationality based on knowledge expressed by such massively influential figures as Bacon, Descartes and Condorcet. We have been living their dreams for some centuries and have profited greatly from our exploration of the knowledge level. Bacon's aphorism has proved wholly true:

> "Human knowledge and human power meet in one; for where the cause is not known the effect cannot be produced. Nature to be commanded must be obeyed; and that which in contemplation is as the cause is in operation as the rule." (Bacon, Aphorism III, Book I of The New Organon, 1878)

However, our reverence for knowledge and the benefits it brings cannot blind us to the counterbalancing problems. Wojciechowski (1983) has analyzed the growth of the total knowledge construct and remarks that all of our problems now are both created by knowledge and mandate the development of further knowledge for their solution. Bickerton has analyzed the evolutionary roots of language and cast serious doubt on its value as a survival trait in a species. He sees language and knowledge in the same *pouvoir/savoir* framework as Foucault as determinants of cultural rigidity:

> "though our models of reality differ inevitably from one another, we find it hard to accept that they are merely models and therefore negotiable. Moreover, in a world of organized inequality, we often cannot get to build models that are truly our own; often, without realizing it, we have to accept the models of others, built not for our benefit but to ensure that those others continue in their knowledge and privilege." (Bickerton, 1990)

The ultimate statement about knowledge should surely come not from the knowledge level but from a poet attempting to speak with a voice beyond words—as Byron said:

> "Sorrow is knowledge: they who know the most
> Must mourn the deepest o'er the fatal truth,
> The Tree of Knowledge is not that of life."

which is echoed in one of the most curious quotes of recent years:

> "Knowledge is an attitude, a passion. Actually an illicit attitude. For the compulsion to know is a mania, just like dipsomania, erotomania, homicidal mania: it produces a character out of balance. It is not at all true that a scientist goes after truth. It goes after him. It is something he suffers from." (Judson 1979 p.97, attributed to Kierkegaard by Wilkins – actually from Musil, *The Man Without Qualities*)

In the cognitive science literature Clancey (1990) has presented a detailed critique of the adverse influence of over-emphasis on the knowledge level in both theoretical and practical paradigms. He sees knowledge as something which we impute to an intelligent agent to account for its behavior:

> "Knowledge is an observer's characterization, not something that the agent owns.…The strong claim is that representations do indeed play a crucial role in human behavior, but they are created fresh, out where they can be perceived; they are not manipulated, indexed, and stored by hidden, inaccessible processes." (Clancey, 1990)

This line of argument has had a strong influence on, for example, the knowledge acquisition community in suggesting that what happens in knowledge engineering is not so much the elicitation of an expert's pre-existing knowledge, but rather the support of the expert's processes in overtly modeling the basis for his or her own skilled performance.

The subtle shift in terminology between *cognitive psychology* and *cognitive science* has marked a major paradigm shift in our approach to intelligent systems. It has opened the question of whether an artificial system, a mechanism, can be intelligent and, if so, how that intelligence differs from ours. In so doing it has raised fundamental questions about the systemic foundations of intelligence. It has also opened questions as to what systems may be regarded as intelligent. If people and computers, why not societies, cultures, the species, the biomass, the universe? What is a cognitive system? In the recent (Schull, 1990) critical discussion of the notion that the species might be regarded as an intelligent agent there was a surprising consensus that this was a reasonable working hypothesis (perhaps, qualified as the Popes asked Copernicus and Galileo, by the avowal that of course it is not really true). Dawkins (1976, 1982) has put forward influential and provocative arguments for both the gene and memetic structures being seen as survival-oriented organisms.

It is thus fitting in the context of this meeting to ask whether we are not being far too timid in our views of computers, cognition and organizations. These are all structures of the lifeworld, coevolving through its evolutionary history, cocultured through its cultural history, coexistent in our modern society. Why do we have three different systems of models, three terminologies, three viewpoints, rather than one. Have we cut the world apart in such a way that most of our problems stem from our attempts to put it together again? The remainder of this paper gives some perspectives which, if not answers, are at least plausible viewpoints from which to peer.

Perspective 1: a surviving intelligence

The evolutionary species perspective is not commonly associated with cognition, organizations or technology. However, it provides major insights into all of these. For example, Luhmann has based his systemic sociology on notions of the ecological niche that go beyond those of conventional evolutionary biology:

> "The world is overwhelmingly complex for every kind of real system... Its possibilities exceed those to which the system has the capacity to respond. A system locates itself in a selectively constituted 'environment' and will disintegrate in the case of disjunction between environment and 'world.' Human beings, however, and they alone, are conscious of the world's complexity and therefore of the possibility of selecting their environment—something which poses fundamental questions of self-preservation. Man has the capacity to comprehend the world, can see alternatives, possibilities, can realize his

own ignorance, and can perceive himself as one who must make decisions." (Luhmann 1979 p.6)

He sees the social world as an extension of the physical environment:

"we invoke a whole new dimension of complexity: the subjective 'I-ness' of other human beings which we experience (perceive) and understand. Since other people have their own first-hand access to the world and can experience things differently they may consequently be a source of profound insecurity for me." (Luhmann 1979 p.6)

He sees cultural conventions as a way of simplifying the social world in such a way that we can operate effectively within it. Thus, from this perspective both socio-biology (Lumsden & Wilson, 1981, 1983) and cultural biology (Boyd & Richerson, 1985) are natural systemic perspectives rather than revolutionary changes in paradigm.

Let us first examine a very broad systemic perspective that sees the primary, indeed the only, evaluative characteristic of a species as being its survival, and derives functionality such as cognition from the prerequisites for survival. It is important to realize that the notion of survival is neither cause nor effect. It is a purely descriptive term—a species is seen to survive from an initial time to a final time because it is identifiably present initially and absent finally. There will be some fuzziness in the identification and scope for debate about what constitutes a unitary species if it evolves and changes form and function, but otherwise survival is a term in an observation. Thus there is no imputation of a 'drive for survival' and even the term 'fitness' for survival is suspect if fitness is read as a causal variable (Gould, 1989).

We impute fitness to a species as our rationalization of why it has happened to survive. If the underlying process is one of pure random selection with no intrinsic causality our rationalizations are meaningless. Confronted with random data people do not see it as random but instead generate increasingly florid hypotheses to give a rational account of it (Gaines, 1976a). Consider a maze of destructive tests into which we introduce a set of automata with initially uniform capabilities. We can say that those who exit were 'fitted' to the ecological niche that is the maze. If the world outside the maze reflects that within it then this 'fitness' may have some predictive power. If, in addition, the automata that exit have changed their behavior in such a way as to better cope with the phenomena of the maze then we can see the growth of 'expertise' which may be further amplified by positive feedback processes in which those who are perceived as 'fittest' are given access to additional mazes (Gaines, 1988).

A similar rationale applies to notions of 'resources' and 'threats' to species survival. Resources are defined to be systems outside the species, access to which is positively correlated with survival. Threats are defined to be what is negatively correlated with survival. One reason we have so much difficulty in evaluating resources and threats with reference to the human species is we do not have the data for such correlations. We can only extrapolate from data from other species that differ markedly from our own. However, the logic is that to survive, the species must have access to the necessary resources and be capable of coping with threats to its survival. Our model of the optimizing effect of the filtering processes of evolution is that systems evolve to maximize their access to resources and minimize their vulnerability to threats. Again, in terms of the arguments above we have to be careful not to impute agency, either internal or external to the species, to this process. That is not to say that agency cannot enter the picture, and that a cognitive, intentional species may not have its own survival as an explicit objective. It reminds us, however, that the question of whether such an objective has any 'survival value' is a completely open one.

If the universe were static a simple model of resource availability and prey-predator relations would rationally model the dynamics of living systems. Until the advent of the human race this planet was a relatively static universe over long periods of evolutionary time. The beginnings of the human race were set in this static universe but our activities soon began to change that universe so that uncertainty about the future became the predominant factor in our survival processes. Changes in the earth that would have taken millions of years began to occur over millennia. Now multiple waves of change occur within our lifetimes. We developed resources far beyond their natural availability and, in so doing, changed the ecology of the earth. We extinguished all predators other than ourselves and again changed the face of the earth. Much of this planet is now a human construct and the distinction between natural and artificial is increasingly becoming meaningless.

Figure 1 shows the system dynamics underlying humanity. The shaded areas show the response to uncertainty. The keys to survival in an uncertain world are three-fold: first to maximize territorial dispersion so that some part of the system is outside the range of a threat; second to maximize cultural diversity so that some part of the system has the capability to survive a threat; third to improve anticipation of the future, passively to predict threats in advance, and actively to rebuild the universe so that they do not occur—those are the roles of science and technology. This is the logic of our present foci of attention: *information technology* for improved anticipation, the *space program* for improved territorial dispersion, and *genetic engineering* for improved cultural diversity.

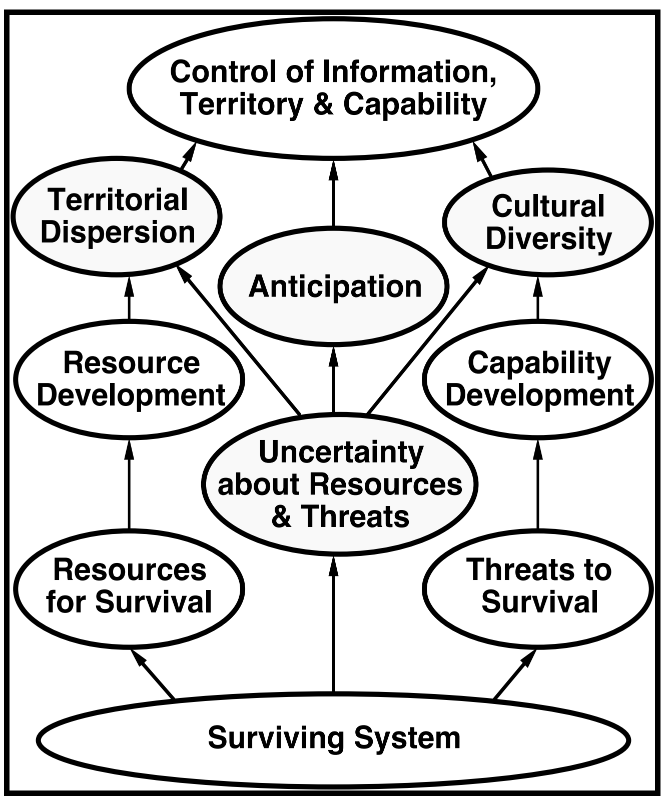

Figure 1 Logic of a surviving system

For the purposes of this paper, it is the role of *anticipation* in Figure 1 that is relevant to our understanding of cognitive processes. The existence of life at all as we know it is dependent on the high stability of certain physical constants and relations that provide a physical environment with a high degree of uniformity over limited regions of time and space (Barrow & Tipler, 1986). The coherence induced by this uniformity is what enables us to bypass Hume's analysis of the lack of logical support for induction and anticipate what is to come tomorrow from the events of today. If we assume that there has been value in increasing the time-span and accuracy of anticipation and that filtering process of evolution has amplified that capability in the human species then evolutionary biology could have major significance, as is claimed (Shephard, 1987; Cosmides & Tooby, 1987), for understanding cognitive systems. The contribution would be to draw attention to the particular relationships between the species and its ecological niches that would through optimization have favored particular cognitive mechanisms. An outstanding example of this line of reasoning in the neural networks literature has been Mead's (1987) analysis of the edge-detection and pattern recognition capabilities of the retina as a by-product of the mechanisms whose function is to compensate for the orders of magnitude swings of light intensity between night and day, light and shade.

The step from the evolution of the species to the cognitive functioning of entities within it is only one form of interaction between systemic levels. From the same perspective we can examine similar relations such as those between organizations and individuals and between the species and biological cells. Miller (1978) gives a comprehensive account of a wide range of living systems based on a common detailed systemic model instantiated at different levels of the bio-system. He distinguishes seven levels:

Supranational System
Society
Organization
Group
Organism
Organ
Cell

Figure 2 Miller's seven levels of biological systems

It is interesting to consider the top level system, effectively the biomass of the planet, as the basic system that acquires knowledge from experience, and regard the lower levels as the functional differentiation of the biomass. A neural network in Miller's framework is a particular *organ* made up of specialist *cells* (neurons) at the lower level, and serving the command and control functions of the *organism* at the level above. In so doing it enables the organism to play specialist roles with *groups* that themselves have specialist roles within *organizations* forming *society* and being part of the *supranational system.*

Thus the survival aspects of intelligence provide a broad systemic perspective that brings together organizations, people and neural systems, together with technologies as part of the support systems for the lifeworld. It emphasizes the distinction between cognitive psychology and cognitive science in allowing us to see cognitive processes as not necessarily localized within the individual human brain but rather as systemic foundations for anticipation in any subsystem of the biomass. The next section examines what can be said about anticipatory processes in general.

Perspective 2: a modeling intelligence

It is conventional to treat an anticipatory system as a model-forming system since that is a natural correlate of anticipation as an effective predictor or creator of the future. It is then conventional to treat the human brain as essentially a modeling system and develop cognitive psychologies upon this foundation. However, this is misleading if one then looks for the 'modeling algorithms' or the 'model.' A neural net perspective is more appropriate because it accounts for the anticipation without specific models or modeling algorithms. As Smolensky (1986) has noted, the apparently bottom-up approach commencing with the net is actually conceptually top-down in accounting for cognition. Figures 1 and 2 give some intuition as to why this is so—the actual net to be considered is a global entity and its survival is the primary logic of our understanding it. What we see as nets at the brain, schema and neuronal levels are entities generated through the anticipatory processes of survival.

As an analogy to underpin the intuition, consider the process whereby sand takes up the shape of an irregular container. We can look at the end result and say that the sand has 'modeled' the container. However, we would find no modeling algorithm, and the existence of the model itself is a construct of our observation that the sand and the container now match one another globally—it is only in a very remote sense a property of the sand. If we wished to expedite and improve the process—to *educate* the sand—we would be foolish to attempt to aid the local *modeling* process by moving individual grains of sand. Instead we would shake the container to provide an environment of maximum opportunity for the sand to settle into the shape of the container. We would shake roughly at first and then increasingly gently.

This is exactly the *modeling* process of the Boltzmann machine and its management through simulated annealing (Aarts & Korst, 1989). It also corresponds to Gibson's (1979) *ecological* model of perception in which we model the world by the brain coming into equilibrium with the stream of incoming sensation. The theoretical foundations for the relation between an anticipatory system and its apparent modeling capability can also be given a simple interpretation. If we consider a perfect anticipatory system that is able to match the output of the system it is anticipating symbol by symbol, then an observer modeling each of the two systems through a behavior-structure adjunction will ascribe the same minimal structure to both up to an isomorphism (Gaines, 1977). Because the observer obtains the same model of both systems, he may suppose that the anticipatory system contains such a model. For example, an operator controlling a linear mechanism apparently has an internal linear model despite the discrete 'bang-bang' nature of the neuro-muscular process precisely to the extent that his or her control is optimal (Gaines, 1969a). These concepts bridge between the amorphous uniformity of nets and the highly structured concepts we have of modeling processes. It is convenient to consider modeling structures as a means of classifying the behaviors and interactions of anticipatory systems at a phenomenological level. However, it is a category error to assume that these structures need necessarily exist at a neurological level.

Klir (1976, 1985) has analyzed the general process of modeling and developed an infrastructure for it that is very widely applicable and can be instantiated at many levels of the living systems hierarchy of Figure 2. Shaw and Gaines (1984) coupled Klir's theory with the insight of Brown into the primitive process of 'making a distinction':

> "a universe comes into being when a space is severed or taken apart...The act is itself already remembered, even if unconsciously, as our first attempt to distinguish different

things in a world where, in the first place, the boundaries can be drawn anywhere we please. At this stage the universe cannot be distinguished from how we act upon it, and the world may seem like shifting sand beneath our feet...Although all forms, and thus all universes, are possible, and any particular form is mutable, it becomes evident that the laws relating such forms are the same in any universe." (Brown 1969 p.v)

They recast Klir's modeling hierarchy as one of distinctions and distinctions among distinctions as shown in Figure 3. A general modeling system may itself be modeled as a process that makes distinctions in the world, gathers data in terms of those distinctions, selects from a repertoire of models those which best generate the data, analyzes relations between the structures of such models, and recursively repeats such analysis to generate higher levels of the hierarchy.

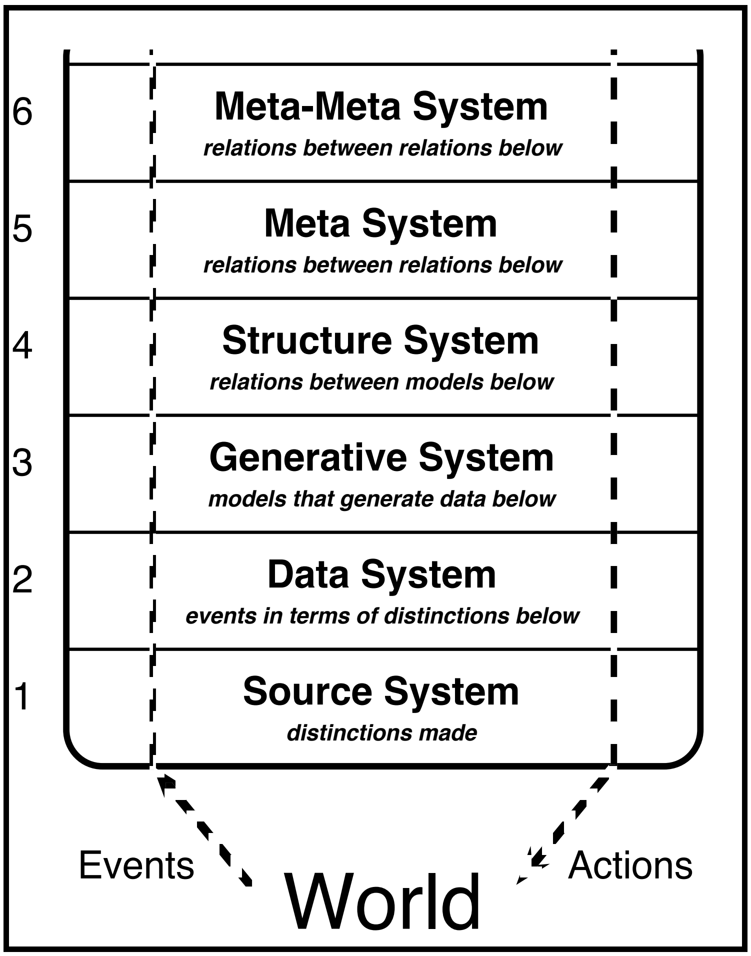

Figure 3 Klir's modeling hierarchy

The instantiation of this hierarchy with particular data description languages, model classes and measures of model complexity and model-data approximation has proven in practice to account for the wide range of mathematical modeling techniques in practical use (Gaines, 1977; Klir, 1985). It is interesting as an account of generalized 'learning' processes since it makes clear the presuppositions necessary for modeling to take place—a *tabula rasa* cannot begin to model and some degree of 'innateness' is required. The trade-off between the amount of data needed in learning and the innately 'assumed' constraints upon the world can be investigated (Gaines, 1976b), as can that with the socio-cultural filtering of data to improve its support of learning

(Gaines, 1989). Fodor-style (1986) arguments about the innateness of cognitive processes can be investigated in terms of the presupposed structures at each level of Klir's modeling hierarchy, together with the possible cultural mechanisms for ensuring that the presuppositions are correct and met in experience. We are in a position to operationalize Kant's *synthetic a priori*, the phenomenon where we bring to our apprehension of the world presuppositions that do not become effective until they are used to model experience:

> "though all our knowledge begins with experience, it by no means follows, that all arises out of experience. For, on the contrary, it is quite possible that our empirical knowledge is a compound of that which we receive through impressions, and that which the faculty of cognition supplies from itself." (Kant 1897 p.1, orig.1781)

Pope (1984) has noted that distinction-making hierarchies such as that of Figure 3 are common in a wide range of different cultures, and that they have another dimension in that the recursive upward-building process may be seen for what it is and transcended. We may interact with a world, begin to make distinctions about it, begin to make distinctions about these distinctions, and then recognize the distinction-making process. This does not necessarily prevent us from continuing to build the hierarchy but it does also allow us to step outside it and reflectively treat our own modeling processes as phenomena which we are able to model. This reflective step, of 'modeling the modeling' is distinct from the abstractive set of subsuming more and more modeling within a unified framework.

If the world being modeled is a socio-cultural world of other modeling agents there is an intrinsic instability in the model process. My model of you is affected by your model of me, and by model of the modeling processes underlying your model of me, and by my model of your model of the modeling processes underlying my model of you, and so on. Lefebvre (1982) uses this mutually referential framework to develop a formal basis for ethical systems based on remarkably sparse logical primitives. It is also the basis for Garfinkel's insight into the essential reflexivity of society:

> "Not only does commonsense knowledge portray a real society for members, but in the manner of self-fulfilling prophecy the features of the real society are produced by person's motivated compliance with these background expectancies." (Garfinkel, 1967, p.53)

One may instantiate Klir's hierarchy in a number of different contexts using the vocabularies of psychology, anthropology, organizational science, education, artificial intelligence, and so on, to develop systemic architectures for cognitive processes in a wide range of systems. Figure 4 shows a variant of this hierarchy emphasizing the cognitive processes involved in modeling the world and their definitions in abstract, systemic terms (Gaines, 1989):

- To *recognize* at the lowest level is the capability to notice recurrence of the 'same' events in the world when they recur. This is already a significant cognitive act because 'same' is subject to personal definition, and the concept that events recur is a strong presupposition. Recognition is fundamental to any modeling system but is in itself a weak operation since it is dependent on the recurrence to make use of the data.
- To *recall* at the next level is the capability to regenerate the distinction used in recognition internally so that it is itself an 'event' that may be processed. This facility to recreate events in the 'imagination' is fundamental to the existence of the cognitive process, detaching human knowledge processing from the immediacy of experience.

• To *model* at the next level is the capability to derive the distinction used in recognition and recall from other distinctions that may themselves not relate directly to experience. This facility to 'explain' events in terms of 'deeper' distinctions that only indirectly relate to experience is again fundamental to the efficiency of the cognitive process, allowing novel distinctions to be developed that efficiently encode wide ranges of otherwise unrelated experience.

• To *reconstrue* at the next level is the capability to derive one distinction from multiple models. This facility to move between modeling systems is fundamental to the adaptability of the cognitive process, and the human species, allowing a wide repertoire of anticipatory sub-systems to be developed to cope with the variety of the world.

• To *abstract* at the next level is the capability to detach distinctions from their sources and make the relations between models themselves subject to study. This facility to study the world of modeling as if it were a world of experience is fundamental to the externalization and growth of human knowledge as a cumulative by-product of the anticipatory process. It makes the expertise of the species largely independent of that of existing individuals.

• To *originate* at the next level is the capability to treat the distinction making process itself as a human activity, subject to choice and change, and to generate distinctions in themselves. This freedom raises many questions as to the nature of 'reality', of the 'wisdom' of certain distinctions, and of the relationship of the distinction-making, cognitive and knowledge processes to the nature of the individual and the survival of the species.

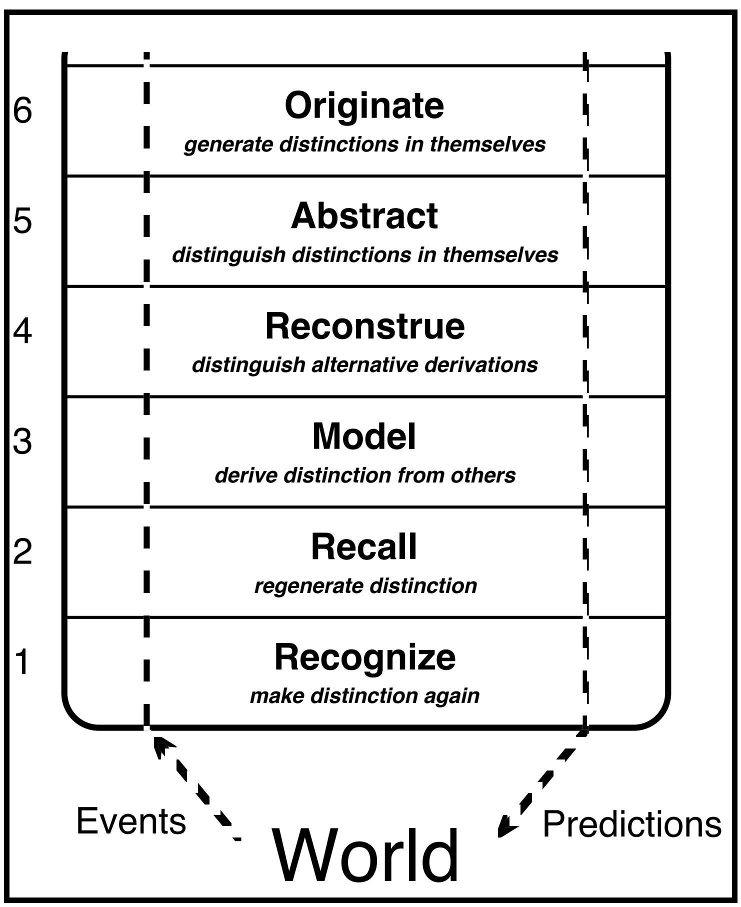

Figure 4 The modeling hierarchy in a psychological instantiation

The information flows in the hierarchies of Figures 3 and 4 are very significant. In prediction the key distinction is to what degree a level accounts for the information flowing through it and hence this distinction may be termed one of *surprise* (Gaines, 1977). Surprise goes in opposition to the degree of membership of a predicted event to an actual event and the expected surprise is a form of entropy. Surprise at the lowest level of the hierarchy corresponds to distinctions being inadequate to capture events; surprise at the next level to inadequate variety to experience events; at the next level to inadequate approximation to predict events; at the next level to inadequate simplicity to explain events; at the next level to inadequate comprehensiveness to account for events.

The formal theory of modeling is one in which models are selected at each level down the hierarchy to minimize the rate at which surprise is passing up the hierarchy. The criteria for model selection independent of the data are generally thought of as being ones of simplicity/complexity: of two models which fit the data equally well choose the simplest. However, notions of simplicity/complexity are not well-defined nor intrinsic to the class of models. The simplicity/complexity ordering is arbitrary and in its most general form is just one of preference. Hence the general modeling schema is one in which surprise flows up the hierarchy and preference flows down. In situations that are mathematically well-defined, such as determining the structure of a stochastic automaton from its behavior, such a model schema gives the correct results (Gaines, 1977). Conversely, the success of the schema in stabilizing with regard to a given world defines the characteristics of that world.

Thus the basic modeling schema for learning from experience is one in which surprise flows up the hierarchy and preferences flow down. In primitive organisms only the lower levels of the hierarchy are developed, surprise is generated from experience and preference is genetically encoded. In higher organisms the modeling process generalizes both surprise and preference to cope with novel environments. Human life has developed the upper levels of the hierarchy and detached surprise from experience and preference from its genetic roots. Surprise can flow up from a level without flowing into it from below because the processes at that level have generated novelty. Preference can be generated at a high level detached from both experience and genetic origins and flow down to affect the relations of the organism to the world.

There is physiological and behavioral evidence of the existence within the brain of the two channels of communication shown in Fig.2 (Tucker & Williamson 1984). The arousal system passes surprise upwards to the cortex from the limbic region when unexpected events occur. The activation system passes preferences down from the cortex to the motor regions. Emotion also has a direct interpretation in terms of these information flows. Melges (1982) notes that:

> "the normal function of emotions is to attune the person to overall discrepancies between the present and the future so that he adjusts his plans of action to his future images."

Thus emotions may be seen as derived from surprise with the type of emotion varying according to circumstances. The deviation from the model may be construed as having adverse or beneficial consequences, being distracting, requiring attention, investigation, action, and so on. This is consistent with Kelly's (1955) notion that negative emotions arise through the violation of core constructs (McCoy 1981). In the modeling hierarchy such core constructs are distinctions that we prefer not to change. From a systemic point of view human feeling tones are signals directing the inductive inference process. This is the basis of Gray's (1979) insight that emotions structure cognition and memory—a modeling system does not need to store what it can anticipate, and hence changes in a system's model that we interpret as 'memory' processes correspond to failures in anticipation which are associated with emotions that are the system's cognitive interpretation of surprise.

The steps from survival through anticipation to modeling and its infrastructure have generated a perspective in which the emphasis on information flows in cognitive science is natural and expected. However, again, there is nothing that has been assumed that differentiates the modeling processes of the person from those of any other cognitive system. Our notions of anticipation and modeling apply as well to organizations as to people. Cognitive psychology consists of cognitive science with an overlay of psychological terminology. Even notions of emotion are applicable to organizations, not as metaphors, but as an interpretation of the evaluation of discrepancies in the modeling process.

Perspective 3: a distributed intelligence

So far, I have emphasized that there is a unitary framework that can be applied to cognitive systems at all levels of the hierarchy of Figure 2. However, the model developed can also be applied integratively to analyze the relations between levels. What are people as components of organizations and societies? What are neurons as components of people and cultures? If we return to the species perspective for a moment, and consider the cognitive unit to be the biomass then in terms of territory, diversity and risk it makes sense for that biomass to distribute itself in such a way that severe damage to its parts has little effect on its whole yet models generated by its parts may be shared by the whole—a great recipe for distributing brains among little mobile sculls. Our folk evolutionary biology may tell us that is not how it happened, but our systemic analysis will tell us that it does not matter too much if our model is not historically sound provided it is a good model of the system now. A deeper investigation of primate nurture practices may suggest that our naive model is not so wrong after all.

The simple model that the distributed intelligence making up the biomass has people as functional units, however, misses much of the richness of the processes involved. We are egocentric and have somehow located our egos in our skulls. This view has been supported by enlightenment philosophy from Descartes through Husserl to Sartre—cogito, ergo sum—the ego turning toward the object—the nothingness within me providing the gap by which I may become cognizant of others. The first person singular is the cognizing agent, and yet there is no fundamental reason for this. Only in Hegel (1929, orig.1812) do we find a clear systemic model that does not locate cognitive processes in individuals. However, his terminology is usually misappropriated to apply to *our* being, not that of an arbitrary system, being and reflecting upon its being.

From a systemic point of view any cross section of the modeling hierarchy may be a possible partitioning of the agents in a distributed cognizant system, whether organization, group, person, role, module or neural complex. Simmel made this inter-relation of wholes and parts the center piece of his sociology:

> "Society strives to be a whole, an organic unit of which the individuals must be mere members. Society asks of the individual that he employ all his strength in the service of the special functions which he has to exercise as a member of it; that he so modify himself as to become the most suitable vehicle for this function….man has the capacity to decompose himself into parts and to feel any one of these as his proper self." (Simmel, 1950, pp.58-59)

Simmel's insight that the group member is always a fragment of a person, a role created precisely to enable the person to enter the group has been developed extensively by Wolff with his notions of *surrender* and *catch*:

> "From the standpoint of the world of everyday life, the mathematician, as we often put it, lives in the 'world of mathematics', dealing with 'nonreal' elements, notably numbers, whose relation to 'real' things, to 'reality', is not part of his concern. Analogously for the logician. What makes our subject-object approach to this attitude misleading is the fact that the subject, the student of mathematics or logic—his or her individuality, including motives and attitudes—is irrelevant for our understanding; the only thing that counts is the pursuit, with its results and questions." (Wolff 1976 pp.162-163)

He makes the key point that not only does the real world**,** the object**,** disappear to be replaced by the world of mathematics**,** but also that in entering into this world the person doing mathematics, the subject**,** also disappears to be replaced by a new entity, the mathematician.

Wolff was not alone in these insights and there are two further models which develop and complement his. In terms of his "subject" Pask's (1975) concept of "P-individuals" as coherent psychological processes capable of engaging in conversations is a useful representation of the results of Wolff's "surrender", particularly when we note that several P-individuals may execute within a single processor. Thus 'the mathematician' may engage in conversation with 'the physicist' or 'the statesman' all of whom happen to use the same brain for their processing. In terms of Wolff's "object" Popper's (1968) concept of a "third world" of "statements in themselves" is a useful representation of that which we "catch", particularly when we note its distinct ontological status:

> "I regard the third world as being essentially the product of the human mind. It is we who create third-world objects. That these objects have their own inherent or autonomous laws which create unintended and unforeseeable consequences is only one instance (although a very interesting one) of a more general rule, the rule that all our actions have such consequences." (Popper, 1974 p.148)

Pask goes beyond Simmel in conceiving that a P-Individual is not just what we conventionally term a 'role' within a person (which he terms an M-Individual, or mechanically characterized individual) but may itself be composed of a number of roles coming together to form a unity that we conventionally term a group or organization:

> "a P-Individual...has many of the properties ascribed by anthropologists to a role, in society or industry, for example. A P-Individual is also a procedure and, as such, is run or executed in some M-Individual, qua processor. However, it is quite exceptional to discover the (usually assumed) one to one correspondence between M-Individuals and P-Individuals." Pask (1975 p.302)

Shaw (1985) has developed Pask's notions within the framework of personal construct psychology to show how Kelly's cognitive psychology may be used to account for the psychological processes not only of individual people but also for that of functional groups such as a nuclear family or a product executive.

The human species as variously distributed intelligence may be analyzed within the framework of the modeling hierarchy already developed. Figure 5 shows how the species itself may be treated as an anticipatory system with various imputed modeling processes that may be seen as carried out by various levels of sub-organization, themselves constituted through roles within individuals. From this perspective and organization, or a role, is a cross section of the representation of the overall anticipatory system within the modeling hierarchy.

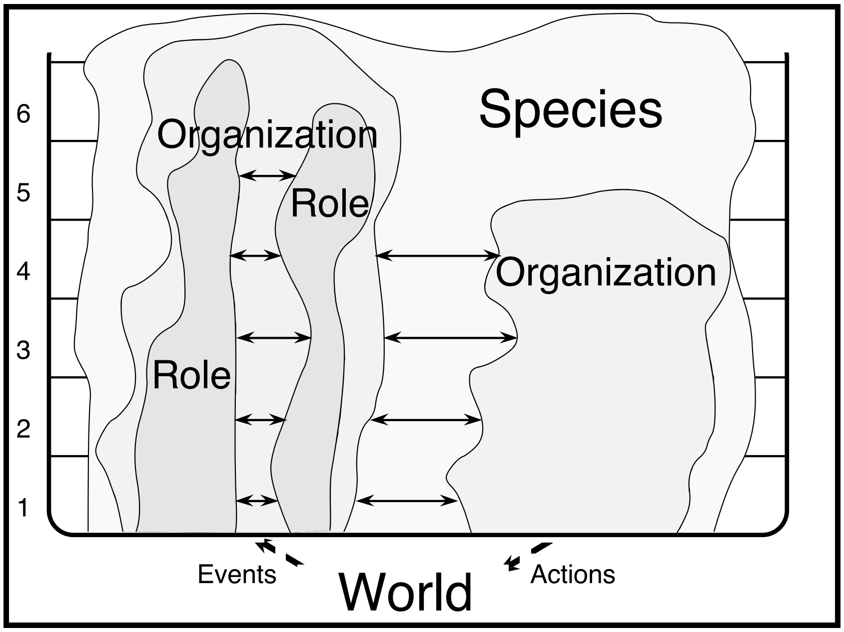

Figure 5 Psychological and social organizations as cross sections of the modeling hierarchy

In particular, this analysis suggests that theories of cognitive agencies should be applicable to all levels of intelligent organization, not just the human person. It draws attention to the potential artefacts inherent in perspectives that place undue emphasis upon the individual, reifying one aspect of localized cognitive activity and neglecting its embedding in a larger context. Figure 5 emphasizes that the boundaries placed around cognitive entities are themselves part of the process whereby we model them, and different placements will lead to different, but related, models. When we study the inter-model relations in cultural, organizational and social psychology, it is illuminating to see them generated by distinctions that are themselves part of the processes being studied. We cannot escape the modeling process but we can attempt to make overt it's current preconceptions, deconstructing not just our theoretical frameworks but the personal, cultural and social environments in which they have been developed.

We can gain new insights into the nature of language and knowledge within this framework of Figure 5. If the biomass is partitioned into semi-autonomous, physically distinct units, how does it coordinate the activities of its components? Systemically, language may be seen as a by-product of such communication. What functions language has in a particular situation will depend on what levels within the hierarchy coordination is required. In ethnomethodological terms, language and knowledge have to be seen as *situated* in the total context of activities within the lifeworld (Garfinkel, 1967).

At the lowest levels of the modeling hierarchy it is not the symbolic aspect of language which is relevant. We coordinate reflexive actions at the lowest level by mimicry. We coordinate rule-based conformity at the next level by reinforcement. These are the levels of Hall's (1959) *informal* and *formal cultures*, respectively. It is only at the next level that his *technical culture* and overt knowledge constructs comes into play. As we go up the hierarchy our linguistic needs become more abstract and what is communicated becomes less associated with experience and more with the way in which we communicate our models in themselves. These are the levels of Popper's third world of objective knowledge. Figure 6 attempts to capture these concepts by showing the modeling hierarchy on the right in terms of connection between events and actions at each level, and on the right the coordination, communication and knowledge transfer mechanisms involved across society.

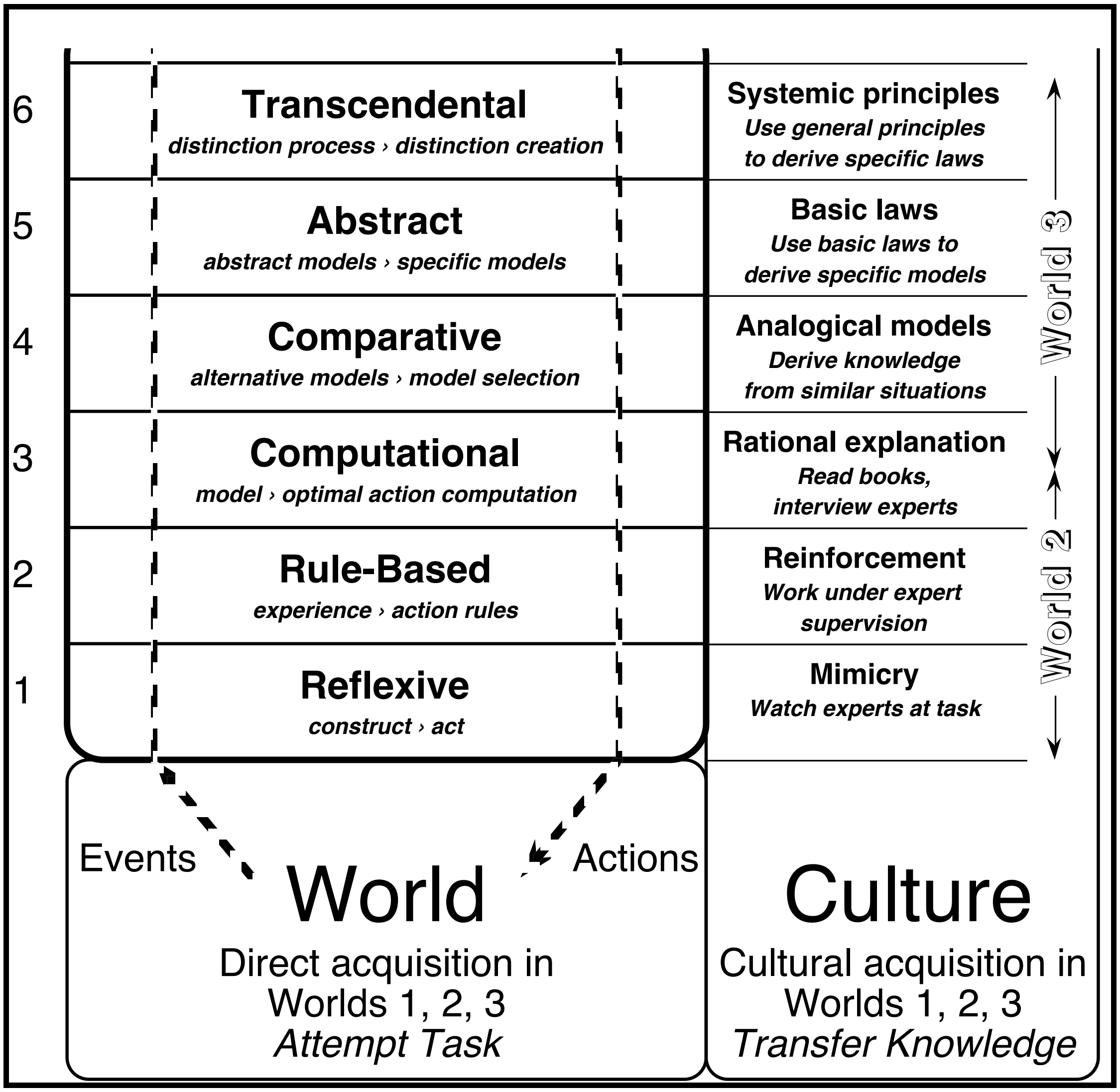

Figure 6 Control and coordination within the modeling hierarchy

Thus language and knowledge can be seen as byproducts of distributed agency. The work of Vygotsky (1934) and Luria (1961) on the role of language in aiding the performance of perceptual-motor skills fits nicely within this framework as communication between two roles, or Paskian P-Individuals, within one head. However, the framework bypasses, as I think it should, the role of language in the mental processes of the individual. Language may be needed for internal communication between Simmel's fragments that we have created in order to play roles in society. Because it is needed for external coordination it may well become used for internal coordination. However, there is no systemic reason for this to happen universally. Most of our mental processes may be not so much pre-linguistic as utterly independent of language. This is a matter for empirical study.

Conclusions

I saw this paper as an opportunity to draw attention to some misconceptions about the nature of cognition that seem to me serious impediments to progress in both cognitive science and the understanding of organizations.

One misconception is the role of the computer in cognitive science. In general the computer has provided the capability to operationalize theory for all sciences. The time scales of that provision correspond to the development of cognitive science in North America, but that is coincidental. The computer has no different role in the operationalization of theories of the human mind than it has for physics or archeology. It is an important development for all sciences.

The computational metaphor is somewhat different. Metaphors have a major role to play in all scientific creativity and they cannot be judged as right or wrong, only as more or less useful. For many of us the computer is the most complex mechanism with which we have substantial direct experience, and it is reasonable if we use it as an aid to understanding mechanistic models of the mind. Two questions then arise: is the computational metaphor misleading; and is a mechanistic model of the mind appropriate?

The computational metaphor could well be misleading if we take it too literally. Current digital computers are mechanisms designed to be discrete in space and time and many basic results about their operation and capabilities depend on that discreteness. In the past twenty years digital computers have come to dominate the commercial scene and we have forgotten the analog and stochastic computers of the 1960s (Gaines, 1969b). Neural networks have reintroduced the analog and stochastic paradigms and provide us with a new computational metaphor, one in which Shannon's coding theorem may have more to say than Church's thesis.

In answer to my second question, mechanism is always a legitimate paradigm. It has served us well and will continue to do so. In particular, the development of chaos theory in the 1980s has given us precise formal foundations for the old issues of emergence—how can complex behavior arise out of simple mechanism, and why mechanism does not imply determinism. There is a rich new understanding of mechanism and behavior in chaos theory and it is already being applied to neurology (Basar, 1990) and social dynamics (Dendrinos & Sonis, 1990).

The misconception that underlies some of our views of mechanism, is that there must be a single unitary perspective that is correct, and that different perspectives are necessarily competitive. From a systemic point of view this is absurd, but it seems to be part of the linear thinking that characterizes Western scientific education.

Pepper's (1942) work on *world hypotheses* completely analyzed these issues some forty years ago. He defines world hypotheses as unrestricted products of knowledge which cannot reject anything as irrelevant and analyses them in terms of their root metaphors, of which one is mechanism. He proposes that someone desiring to understand the world will take an area of commonsense fact and use this as a basic analogy with which to understand other areas. The structural characteristics of this root metaphor become the categories for his basic concepts of explanation and description. He proposes that:

I. A world hypothesis is determined by its root metaphor;

II. Each world hypothesis is autonomous;

III. Eclecticism is confusing;

IV. Concepts which have lost contact with their root metaphors are empty abstractions.

Pepper derives four root metaphors underlying world hypotheses: formism, mechanism, contextualism and organicism. The importance of this work is that, from a systemic point of view, world hypotheses are complete, autonomous, non-comparable and can completely account for one another. They are cognitive perspectives on the world not competing theories. If they compete it is in their attractiveness and utility, not in their truth.

The strongly functionalist perspective adopted in this paper is clearly subject to the criticism cited in the introduction—Bruner's argument that cognitive science should be one of meaning, not one of information flows. The major argument of the paper has been that, as a world hypothesis, a systemic, functionalist analysis provides a very comprehensive account not only of the cognitive processes of individuals but also those of organizations, and that this account can itself be derived from considerations as to the nature of the human species. That is, one genre of cognitive science, based on the analysis of anticipation, distribution, and the associated modeling processes and information flows, gives an extraordinarily powerful tool for the understanding of a wide range of cognitive systems and their inter-relationships. However, other world hypotheses, are both possible and of equivalent status. The reduction of human life to information processing is a useful perspective rather than a uniquely correct or particularly privileged view.

Humanity's search for meaning transcends its reduction to physical and biological processes and derived functions. It is wholly inappropriate to assume that *meaning* should be derived from within a functionalist perspective. We can develop a relationship between the modeling framework and the notion of meaning by noting that *what* we are modeling is open to choice and not necessarily determined by anything other than our choice. Meaning involves social constructs that Castoriadis (1987) rightly terms *imaginary*. They arise solely within our models and have no referents except in our societies and cultures, which are themselves imaginary. We legitimate each age (Blumenberg, 1983). If this is seen to denigrate the nature of meaning then the point is being missed. It is the human capability to fantasize and reify models that are not grounded in our physical environments or biological processes that gives rise to those human characteristics that we most value. It is irrelevant to analyze these activities in terms of survival value, correspondence to reality, and so on. The imposition of meaning is itself a world hypothesis that is totally self-contained and self-validating.

It is a major role of art to remind us that our humanity is not determined by natural law but depends on our imaginations. Without this insight, morality, ethics and value, may be perceived as derived from the physical world and imposed on us much as a brick wall imposes itself on our perception. As a metaphor the impenetrability of the wall, and the hurt when we walk into it, may correspond to the force of a moral precept and the hurt when we break it. As an aid to deep understanding, the metaphor is highly misleading. As Marcuse has noted:

> "The quantification of nature, which led to its explication in terms of mathematical structures, separated reality from all inherent ends and, consequently, separated the true from the good, science from ethics." (Marcuse 1964, p.122)

and Habermas has echoed this in his critique of simplistic approaches to post modernity that attempt to redress the balance by being anti-modern:

> "In everyday communication, cognitive meanings, moral expectations, subjective expressions and evaluations must relate to one another. Communication processes need a

> cultural tradition covering all spheres, cognitive, moral-practical and expressive." (Habermas, 1985)

If there is a relevant misconception in cognitive science it is one based on the completeness of a unitary world hypothesis noted above. Information flows in mechanistic models may be capable of giving a complete behavioral account of all the phenomena of the lifeworld, but they do so in a semantic framework which cannot speak to many of the key issues in that world. We cannot treat those cognitive issues as being the properties of brains resting within skulls. If we are to contribute to them, and I believe cognitive science has much to contribute, we have to take into account their social and cultural dimensions, and not be frightened to add such terms as art, morality and ethics to that of mind. If we do not do so, then our rejoicing at escaping from the confines of behaviorism is based on a curious hallucination.

In recent years we have developed powerful intellectual tools for understanding and, to a limited extent, transcending the frameworks that we have built in establishing scientific disciplines, the tacit cultures that determine legitimate argument forms and which ultimately become major impediments to progress if we do not make them overt. Foucault's (1969) *archeological* approach to the analysis of knowledge provides means to identify the origins of our preconceptions and trace their influence on the development of our disciplines. Derrida's (1967) method of *deconstruction* goes beyond this in emphasizing that this identification itself involves a modeling framework which is equally suspect. We can never escape the modeling process. All we can hope to do is identify our current preconceptions but not try to escape them—deconstruct not destroy—noting that the identification is not uniquely determined, and that its preconceptions are subject to further deconstruction. None of this should be surprising once we have accepted the imaginary nature of society. It would be valuable to apply Foucault's and Derrida's methodologies to cognitive science, but the real benefits will come from internalizing them as part of the theoretical framework and pragmatic methodology of cognitive science. The recursive embedding of the lifeworld in itself is not a problem to be avoided by problem selection, experimental technique and other forms of self-blinding, but rather the generative principle underlying and suffusing both our theory formation and the systems about which we theorize.

My emphasis on the need to escape from egocentricity in this paper does not suppose that individualism can be sensibly replaced with larger abstractions. The group, the organization, the culture, the species, have just as much life about them as the person—they are not empty abstractions. The enlightenment sought to free us of a unitary culture that dictated our thoughts and modes of being. To some extent the modern age did that, although it has replaced it with a unitary culture that is no less oppressive for being based on economic reward than physical punishment. It also promoted a false notion of individualism that attempts to center all explanation upon the ego—we have swung from undervaluing the person to undervaluing the lifeworld.

Systemic perspectives can redress the balance, but not if they are seen as empty abstractions. The danger in attempting to use them to see the larger scene is that we reify our abstract models and are then alienated from the world that we conceive:

> "the reification of abstract phenomena can be interpreted in psychiatric terms as schizophrenia, that is, as a kind of logical disease in which man constructs an abstract world but treats it as if it were real and concrete." (Zijderveld, 1970 p.51)

We have to use the systemic models, the knowledge level, as means to our destination and not as ends in their own right—the mountaineer who comes to identify with the piton will be forever suspended below the peak. Again, the last word is best left to the artist:

> “Leave us to ourselves, without our books, and at once we get into a muddle and lose our way—we don’t know whose side to be on or where to give our allegiance, what to love and what to hate, what to respect and what to despise. We even find it difficult to be human beings... and are always striving to be some unprecedented kind of generalized human being…Soon we shall invent a method of being born from an idea.” (Dostoyevsky 1972 p.123, orig. 1864)

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