SELF-ORGANIZING NATURAL INTELLIGENCE

Self-Organizing Natural Intelligence

Issues of Knowing, Meaning, and Complexity

by

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Dedication

To the memory of my mother,
Mary Magdalene Stanley Estep,
November 24, 1917 –
May 5, 2004

Table of Contents

Introduction

Having been born and raised in the rural coal-filled mountains of southern West Virginia during the nineteen forties, my brothers, sisters and I learned early to respect the earth and other living things. Our parents taught us to tend large areas of land, to plant them thick with crops every year, and take care of our animals. Along with cows, chickens, and our crops, they often spoke of the earth itself as a living thing, and that's the way I grew to see and understand it. The very dirt under our feet was viewed as a precious thing, not something to disparage or belittle, let alone poison or wear out. It was that dirt, after all, that helped create what we saw as the natural miracle of food to eat.

But it was not only our job to plant, harvest then help with canning and storing food in our cellar each year. We also had to keep wild animals from helping themselves too much to our crops and livestock. I suppose it was from my earliest years that I learned the tricks of wildlife, along with the occasional off-the-beaten-path human, to get young plants and the occasional chicken to eat. Almost from necessity, I grew up with a healthy respect for natural intelligence.[1]

It was only quite a few years later when I attended a great university in the Midwest, however, that I learned animals didn't have any intelligence.[2] They didn't have any intelligence, it was claimed, because they have no language abilities.[3] Animals can neither speak nor write any recognized language because they do not have the vocal apparatus, language areas of the brain, and in most cases do not have fingers suited for writing. Hence, so the argument went, they cannot reason. Reasoning in language was the

[1] Unless otherwise indicated, I use "natural intelligence" and "intelligence" interchangeably as that intelligence naturally found in humans and animals. These are in contrast to "artificial intelligence" which is deliberately designed by humans for specific purposes. These terms are more precisely specified and defined later.

[2] I use the term "animal" to refer to nonhuman animals, though obviously humans are animals as well.

[3] The term "language" is taken to refer to any alphanumeric system, with rules of grammar. "Natural language" is taken to refer to languages which are historically given with no explicit rules laid down from the start which govern their use. Such rules continually change. This is in contrast to "artificial language" which is taken to refer to languages that are essentially simple, with rules explicitly set forth. See Nordenstam 1972.

essence of intelligence, the experts claimed, and scores on IQ tests, which animals cannot even take, eventually became circularly definitive of that intelligence. Thus, according to experts, it followed that animals had none.

The Continuing Influence of Behaviorism

At the time, those disciplines that study and conduct research into intelligence were under the influence of the movement known as behaviorism, led by B.F. Skinner. Skinner and his adherents held that all behavior, human and animal, was explainable as responses to external stimuli. Following the classical science model, simple, linear causal chains were taken to explain everything a human or animal does.

Based upon inherited neural mechanisms, behaviorism is a mechanical determinist theory whose origins can actually be traced back many centuries, at least to Descartes. According to Descartes, animals were merely reactive mechanical organisms, like wound-up clocks. They could not feel pain and they certainly possessed no intelligence. They had no intelligence, he claimed, because they had no soul, which meant they also had no free will.

On the other hand, he held that humans do have souls and hence also have freedom of will because they have the ability to reason. Reason, he argued, is the highest achievement of mankind and it is reason and the freedom of our wills that he held distinguishes us from animals. Though our view of animal pain has changed since Descartes, we still largely view them the same way he did, as reactive creatures with no real intelligence.

We also still largely view intelligence the way he did. As the basic S-R theory developed, the more important behaviors of human beings came to be viewed as those that are acquired. Since humans are equipped with a vocal apparatus and language centers in the brain, language could be explained as an acquired, conditioned response to external stimuli. Animals, on the other hand, were and still are largely viewed as creatures equipped solely with reflexes and instinctive behavior. We're all familiar with Pavlov's dogs, taught by classical conditioning to respond in certain ways to external stimuli.

But over many years, even with extraordinary *ad hoc* changes to the basic theory, later passing under other names, it became clear to some researchers that unbiased observation shows that basic stimulus-response schemes do not work. One of the most important things to recognize about early behaviorism is that both humans and animals were and still are largely conceived by some to be passive receptors of external stimuli. Jettisoning earlier concepts such as freedom and will, as well as other references to internal motivation, the aim was to focus solely upon the

environment and external observable forces acting upon both humans and animals. We and our animal friends came to be viewed as reactive organisms, not in control of ourselves; we become whatever external stimuli make us to be.

But innumerable clinical and other studies accumulated irrefutable evidence of failures of S-R schemes to explain even ordinary human and animal behavior. Among many other things, they leave out self-directiveness found in intentional and sometimes prescient, anticipatory behavior involved even in simple everyday problem-solving. They also entirely leave out exploratory, playful, as well as improvised, innovative, and creative (yes—oh that dreaded of concepts to the behaviorists—even creative) activity of both humans and animals. Though later versions of behaviorism were not quite so strict, they nonetheless maintained the basic reactive scheme to explain all behavior.

The basic S-R model remains influential in the behavioral sciences though it is no longer found in its most stark form advocated by Skinner. Still found in intelligence theories by those who call themselves "materialists," "eliminative materialists," "naturalists," and "neural network theorists," among others, the underlying S-R scheme was modified placing more control in neural mechanisms and chemistry of the brain. In place of *single* causal chains whole networks of interconnected causal chains were put in place, acknowledging multiple determinants as well as multiple resultants. The capacity for thought or reason, viewed as exclusively an aspect of specific language portions of the brain, came to be seen as the controlling feature of intelligent behavior.

Myths of the Representational, Top-Down, Linguistic Mind

Among the most persistent myths about intelligence is that language is a necessary condition to think or to act intelligently. Representationalism, the picture of mind or intelligence itself as a large set of symbolic alphanumeric representations of the world with rules for their manipulation, arose as a prominent view along with the computational theory of mind.

This myth is a natural consequence of centuries of influence by twin scholarly movements known as *nominalism* and *conceptualism* that arose long before behaviorism. Basically, nominalism is the view that all we can know of what we may call "reality" is the language we use to describe it. There are no facts out there, objectively existing independent of language speakers. All we have, according to nominalists, are the language labels we use to describe or name our experience. There is always a language representational interface between us and reality, if there is any such thing.

We have no direct or immediate contact with reality; we have nothing of reality itself.

Similarly, conceptualists claim that all we have and can know are concepts "in our minds." There is nothing beyond those, they say, that is real. Though possibly not realizing the historical sources, these twin movements have led some even recently to issue stark pronouncements about "making our own reality."

It is important to stress this essence of nominalism and conceptualism due to their continuing influence upon our view of intelligence. Both doctrines hold that there is nothing cognitive that is not mediated by language. We do not have any *immediate* contact with the world or reality, they claim. We can only have *mediated* contact through language *about* our experience or by way of representations in the brain.

Following this line of argument, however, still others who eventually became known as postmodernists argued even more strongly that nothing in our language can correspond with anything outside of ourselves. Indeed, they still argue that we can make our language do just about whatever we want it to, *hence we can make reality any way we want it to be.* This line of argument extending from earliest nominalism and conceptualism has led to a tradition bereft of moorings tied to concepts such as *fact, evidence,* and *truth*.

Others known as realists argued that though we may only have our language or representations, they must nonetheless correspond to something outside ourselves that we can put to test and verify. But testing and verification must always be done with instruments defined by linguistic means. Any other claims to know must be excluded from the domain of intelligence.

The effect of these combined arguments by both postmodernists and realists has been to entirely remove the locus of intelligence from the person to the mechanics of language and objective representations of reason. Later additional arguments placed the rules governing the mechanics of language and reason in specific areas of the brain. Those parts of the brain became the machine's central processor and the claimed true locus of all intelligence.

Over many centuries, especially since Descartes, the influence of mechanism along with the twin movements of nominalism and conceptualism led to the mechanics of artificial computer languages, which paradoxically became the paradigm for the mechanics, the essence, of *natural* intelligence.

With the development of the neurosciences, especially Hebb's notion of the cell assembly, more attention eventually focused upon the overall dynamics of the brain instead of behaviorist explanations that did not work in any case. Neural systems became important in the development of computer models of the mind.

Additionally, it should be mentioned that the shift from behaviorism to neurology helped to better explain certain diseases such as autism that confounded (and still confounds, to some degree) the experts. Nonetheless, global theories of the brain tending toward global theories of intelligence followed the same representationalism found in nominalism and conceptualism.

Today, representationalism and the computational theory of mind are pervasive in fields such as psychology—especially in intelligence research and IQ studies, and also, obviously, in artificial intelligence. These are determinist, top-down, verbal,[4] knowledge-based approaches to mind and intelligence, still adhering to an underlying though extended mechanical S-R model.

Perhaps the most highly influential view today is that intelligence is found in those neural centers of the brain where purported "grammar genes" are the controlling feature. The science of genetics has been used to add yet another layer of determinism to the model. It is a *genetic* determinist, logico-linguistic, top-down model driving the train of intelligence research in the U.S. But it is an approach that has proven to be a manifest failure to capture even the most rudimentary aspects of any natural intelligence system.

Among other things, this approach leaves entire categories of human as well as animal cognition out of the intelligence picture altogether. It leaves out entire facets of complex sensorimotor awareness, control, and intentional behavior evident even in simple tasks because of the prior assumption that these have nothing or very little to do with intelligence.

The arguments upholding this view are based not only upon false assumptions about the science of genetics but also false assumptions about human cognition generally. Moreover, they are based upon ignoring reams of documented evidence of human and animal intelligent behavior found in everyday experience that is unrelated to language. At the most fundamental level, they are based upon the false assumption that intentional doings, *knowing how,* are reducible to *knowledge that* (or just *"knowledge"*),[5] the kind of knowing we can put in declarative sentences

[4] The word "verbal" means "by linguistic means." It refers to communication by language, either spoken or written.

[5] The term "procedural", as in "procedural knowledge", is sometimes used to refer to *knowing how*. I will use the phrase "knowledge that" and the term "knowledge" equivalently to refer to declarative assertions, or claims to know, in language. In the

and encode into machines. This assumption underlies virtually all existing theory of intelligence, as well as the standardized tests used to measure it, even while extensive evidence shows that it is false. Indeed, the evidence shows that *knowing how* and *knowledge that* are two very different kinds of intelligence, not one.

Knowing How and Sensorimotor Intelligence

This astonishing neglect of the intelligence of *knowing how* has not only diminished and thwarted our understanding of basic performances or practical tasks such as knowing how to tie one's shoes or drive a car, it entirely leaves out whole facets involved in understanding what everyone would agree is highly intelligent behavior such as knowing how to prove complex mathematical theorems or perform surgery. Indeed, evidence shows that the intelligence of knowing how expands across *all* our intelligence. It is the most fundamental kind of intelligence, found in the most practical or procedural physical tasks to the highest levels of human thought and creative endeavors of the mind. Yet it is missing almost entirely in predominant theories of intelligence.

To some degree there is an irony involved in the fact that the very top-down, logico-linguistic and knowledge-based serial and additive approach to intelligence so pervasive in intelligence research cannot address even basic intentional doings. It especially cannot address sensorimotor performances found in those who are largely visually-oriented (as opposed to verbal), nor does it capture the *know how* involved in fundamental tasks of basic math and logic. It leaves out an entire panoply of indexical signs of intelligence traversing the entire spectrum of intentional doings.

In contrast to much of the research directed to human intelligence, many researchers in artificial intelligence have more recently turned to more mathematical and less logical approaches to understanding and simulating human and animal intelligence. Based in part on the development of high-speed computers and advanced imaging techniques, great strides have been made by designing sensory architectures for biologically inspired approaches, especially in robotics. This was necessary to get away from the Good Old Fashioned Artificial Intelligence (GOFAI) approach emphasizing the knowledge-based, top-down, serial approach to intelligence founded upon so many false assumptions.

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philosophical literature "knowledge that" is used to emphasize the declarative sentence or proposition following "that". "Knowing how" was earlier called "practical intelligence" by the ancients (though they did not use that notion to mean the same thing we do today when we generally use that phrase).

Yet even the more recent mathematical approaches are still inadequate. For example, though neural network (connectionist) approaches are promising in efforts to simulate actual perceptual and intentional sensorimotor performances, they are fraught with some fundamental flaws. Those flaws largely center on some of the same basic classical science assumptions that simple causal chains of the top-down, linear, functional-block oriented strategies are sufficient to describe and explain the emergent dynamics of actual intelligence.

Moreover, these approaches still largely rely upon the old representationalist, top-down *knowledge that* assumptions and fail to capture the unique, context-sensitive smoothness, timing, and immediacy of human and animal sensory and sensorimotor awareness of *knowing how* clearly evident in intelligent behavior spanning *all* intelligence.

In other areas, while some recent animal intelligence researchers affirm that language is not necessary for thought (Marc Hauser 2000), they still largely rely upon those same representationalist models. They still follow what amounts to the same top-down computational model. Moreover, their efforts are premised as well upon faulty classical science reductionist, linear assumptions, striving for simple, direct causal chains that cannot account for emergent intelligence phenomena found in actual experience.

Among other things, extensive empirical research demonstrates the need for a broad theory of *signs* by which both animals and humans exhibit as well as *disclose* their cognition in the shapes and patterns of what they do. For example, as things now stand, major theories of intelligence do not include accounts of relatively ordinary stealth patterns used by both humans and animals to elude predators. They also neglect more complex and interesting deadly offensive patterns such as aggressive mimicry found in both humans and animals.

Likewise, these theories do not touch upon highly intelligent improvisational elements found in the likes of both defensive and offensive combat behavior as well as insurgency and counter-insurgency strategies. They have made few attempts to tie their theories of intelligence to the concepts and strategies commonly debated in and around intelligence agencies in the capitals of the world and often deployed by military as well as criminal and terrorist groups.

Toward Signs and Self-Organization

A broad theory of signs would include a set of classifications, clearly defined, of the self-organizing and emerging patterns and shapes human and animal cognition takes in the world extending far beyond written and spoken natural and artificial language behavior. Moreover, it would extend

beyond patterns of individuals to include patterns of teams, networks, and coordinated groups or "cells" of individuals who share common objectives on many levels. Yet to find efforts to set forth such a theory of signs, one must look back many decades in the annals of philosophy.

Additionally, none of the predominant verbal-based theories of intelligence today address the *self-organizing dynamics* of intelligence found in the actual experience of living sentient beings, let alone groups of such beings. The predominant theories are static, reductionist, nondynamic, and may as well be describing programmed, unmoving automatons. The actual living, breathing, moving, brilliant, sweating, angry, laughing, planning, violent, coordinating, improvising, and loving activity found in the intelligent behavior of living beings is largely if not entirely missing.

To summarize, right now intelligence is largely viewed as a one-dimensional, top-down, language-and number-based special *single* ability that some have more of than others. It is viewed as given largely at birth in one's genetic inheritance, and cannot be modified to any significant degree by education, training, or experience.

Moreover, the predominant view is that intelligence is found in one or two parts of the brain but not in others. It is definitely not found in other parts of the body or in anything the body does that is *unrelated* to the use of language, logic, and number. It is definitely not found in lower animals or at least certainly not in the superior ways it is found in us (or at least in some of us, so the argument goes) due to language centers of our brains. Most importantly, it is held to be entirely measured by standardized IQ tests.

Unlike just about everything else in the natural world, intelligence is viewed as this special single ability that does not emerge from innumerable interactions among those components making up a life. On the contrary, this inborn central processor is that special ability that anoints riches and material success on those who are privileged to be born with much of it. Like Venus issuing forth from the head of Zeus, intelligence is viewed as issuing forth from certain parts of a superior brain that is master of all it surveys. And like a goddess that imparts favors on all who worship her, intelligence assures the one who has a lot of it much success and power in this world.

It is this almost *super*natural and strictly hierarchical view of intelligence that has formed our view of humanity itself, as well as our relation with the rest of the animal kingdom. It is a view that has also wrought sometimes miserable and often very inhumane consequences to the world. Cut off from the natural world in many ways, it is little wonder that it is this view—more than just about anything else—that not only gave

rise to what C.P. Snow called the "Two Cultures," but to some of the most pernicious social and economic divisions found in our history.

The world needs a different way of looking at intelligence

I have approached natural intelligence as a multi- and interdisciplinary phenomenon. I view intelligence as very much a part of the natural world and hence as a living thing, an emerging richly textured set of patterns that are highly complex, dynamic, self-organizing, and adaptive.

In both scope and content, this book draws upon the behavioral sciences, the neurosciences, philosophy, as well as computer sciences and engineering to address the above and many more fundamental issues about the nature of intelligence. Above all, I wish to broaden and re-carve the universe of intelligence without the biases of historical accident and whims of power, based solely upon the facts of intelligence found in the natural world.

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Silverton, Colorado

List of Abbreviations

AI	Artificial Intelligence
AIP	Anterior, intra parietal region
AL	Artificial Life
ASL	American Sign Language
CNS	Central Nervous System
ERP	Event Related Potential
fMRI	Functional Magnetic Resonance Imaging
GOFAI	Good Old Fashioned Artificial Intelligence
LGN	Lateral Geniculate Nucleus
MIP	Medial intra parietal region
M1	Primary Motor Cortex
MT	Middle Temporal
MT+	Middle Temporal complex
MST	Medial Superior Temporal
MSTl	Medial Superior Temporal lateral
MSTd	Medial Superior Temporal dorsal
PF	Performative Intelligence
QL	Qualitative Intelligence
QN	Quantitative Intelligence
rCBF	Rate of Cerebral Blood Flow
RTC	Reticulo-Thalamo-Cortical
SDT	Signal Detection Theory
SIGGS	Set, Information, Graph, General Systems
SOFM	Self-Organizing Feature Map
TBC	The Bell Curve
TSS	Test Score Semantics
UG	Universal Grammar
VIP	Ventral intra parietal region
WISC	Wechsler Intelligence Scale for Children
WAIS	Wechsler Adult Intelligence Scale-
WAIS-R	Wechsler Adult Intelligence Scale-Revised [WAIS-R],

List of Figures and Tables

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