In Context

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The Newsletter of **The Nature Institute**

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Searching for Wholeness

Dear Readers,

In this issue you will find a discussion of local communities in a globalizing era, a sketch of the elephant as a creature of intelligence, and an analysis of the many claims about the importance of the human genome. A wildly diverse collection of articles, you might think! But there's more unity here than is evident at first glance.

In fact, unity itself is the unifying theme. More particularly, these articles are all concerned with the organic relation between part and whole.

- Globalization and localization are often construed as pure opposites. But a community *can* become more distinctively and colorfully local even as it takes its place more consciously within a global regime. Might the local character and the global awareness, properly understood, actually require each other?
- Intelligence is a function, not only of the elephant's brain, but also, for example, of its wonderfully dextrous trunk. No radical compartmentalization of functions is possible. Craig's study of the elephant, excerpted here, is one of a series of research projects that he refers to as "whole-organism biology."
- The attempt to understand the organism in a non-holistic, bottom-up, causal fashion reaches perhaps its purest expression in the popular view that "genes determine organisms." Craig, in collaboration with Johannes Wirz of the Research Laboratory at the Goetheanum in Dornach, Switzerland, shows how far removed from reality this view is. The organism as a whole takes hold of and responds to a particular bit of DNA much as it responds to a particular condition of its external environment.

Of course, what one actually means by "the organism as a whole" is the crux of the matter. Among geneticists today it is routine to disavow "the simplistic, genes-determine-traits view." After all, the organism is "much more complex than that." But the question remains: Do we approach this greater complexity with the same exclusive focus upon linear, cause-and-effect mechanisms — simply multiplying them, invoking feedback loops, and acknowledging a much more tangled mechanical web (but still a *mechanical* web) — or do we recognize the different, qualitative sort of thinking that alone can present us with truly organic wholes?

Such thinking, because it is qualitative, presents us with concepts of the organism that cannot be precisely defined. But they *can* be illustrated, and a good part of the task we have set ourselves at The Nature Institute is not only to explore the contours of a qualitative approach to nature and society, but also to present examples of such an approach in our publications.

We hope you enjoy our attempts in this issue of *In Context.*

Craig Holdrege *Steve Talbott*

Craig Holdrege Steve Talbott

The Nature Institute

for phenomena-centered research and education

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Why Not Globalization?

Following is the text of a talk Steve Talbott gave at the "Technology and Globalization Teach-In" held February 24-25 in New York City. Convened at Hunter College, the Teach-In was organized by the International Forum on Globalization.

Good morning.

Some of you may have seen the January/February issue of *Foreign Policy*, where novelist Mario Vargas Llosa writes about "The Culture of Liberty." Globalization, he tells us, does not suffocate local cultures; it liberates them.

Vargas Llosa does admit that modernization takes a toll on traditional life. "The festivals, attire, customs, ceremonies, rites, and beliefs that in the past gave humanity its folkloric and ethnological variety are progressively disappearing or confining themselves to minority sectors." But he goes on to contend:

First, "When given the option to choose freely, peoples, sometimes counter to what their leaders or intellectual traditionalists would like, opt for modernization without the slightest ambiguity."

Second, "the allegations against globalization and in favor of cultural identity reveal a static conception of culture that has no historical basis." That is, cultures *always* change; the question is only *how* they will do so.

In the third place, the very notion of cultural identity, he says, "is dangerous .... It threatens humanity's most precious achievement: freedom." People are, after all, more than crystallizations of their culture. "The concept of identity, when not employed on an exclusively individual scale, is inherently reductionist and dehumanizing, a collectivist and ideological abstraction...."

Machine vs. Human Thinking

Now, I happen to think there's profound truth in what Vargas Llosa says. And yet, he fails — at least on the evidence of this article — to recognize the extreme distortions and imbalances at work in the globalizing forces we actually see today.

Can we acknowledge these distortions while at the same time holding firmly to what is true in the novelist's remarks? Unfortunately, this is *almost* impossible today, due to our deepening impulse to think like machines. By this I mean: to think with the wooden, either-or mindset that says, globalization *or* localization, individual identity *or* cultural identity.

What I want to do is briefly to characterize this pathology, which goes beyond the particular thoughts we have in our heads. It's reflected in the underlying quality of our thinking activity, whether mechanical on the one hand, or imaginative and organic on the other. A humane and social thinking does not rattle around mechanically between logical opposites. Like the healthy human being, it brings contrary movements into something like the harmony of a dance. So let's try this dance for a moment with the ideas of globalization and localization.

It's obvious enough that globalization won't buy you much if the societies and places you "globalize" are by that very process denatured, devalued, deprived of their local savor. You end up with global relations that are relations of same to same, in which case there isn't much reason to relate. When all the emphasis is on universal connectivity and none is on deepening the distinctive contributions of the people and institutions you are connecting, then everything loses its individual character — which is much the same as losing its existence. You perfect a global syntax for interaction, but there's no one left you'd care to interact with, no one who offers anything different from the homogenized culture that already surrounds you.

Globalization, then, to be meaningful, already includes within itself the necessity for a strengthened movement toward localization. Local communities must gain ever greater powers of self-definition in order to hold the balance against the leveling tendencies of globalization, and by doing this they make globalization worthwhile.

So much for globalization as a self-sufficient ideal. But we can look at localization in the same way. While a local community can provide richly textured contexts worth saving, it's the very nature of context to be unbounded, to open outward without rigid limit. In ecological terms, every habitat is bound up with its neighboring habitats, and so on ever outward. So localization implies an openness to the globe. This is demonstrated by the fact that the people struggling most heroically to preserve their own, locally rooted lives today are being forced to recognize and do battle against an array of global institutions. They become true global citizens precisely because they love the places where they live.

Somehow we have to become flexible and imaginative enough in our thinking to hold these "opposites" — globalization and localization — together in a harmonious counterpoint. It's crucial to acknowledge and credit a certain drive toward universality in the modern human being. But the person who becomes most truly universal will also be the person who becomes most truly individual, centered and grounded in himself. And what is true of the individual is also true of communities. No community can become meaningfully universal or global except by cultivating its own distinctiveness, its own values. Then, the necessities of its ever richer life will impel it toward an appropriate global awareness.

But if globalization and localization need and imply each other, clearly the proper globalization we're talking about has little in common with the destructive process we see today. I do not go global by forsaking my own place, but rather by intensifying its unique significance so far that it finally becomes an achievement, a revelation, of universal import.

Martina Müller

So it's not that we should tell traditional cultures, "Stay as you are." Rather, it's that these cultures should be allowed to evolve according to the intrinsic logic of their own traditions, their own wisdom — which, *of course*, will lead them beyond themselves, and which, *of course*, will be a path influenced by contacts with the rest of the world. But this is quite different from inundating a people beneath foreign ways that have no foundation of support within their own traditions and values, and that are inherently corrosive to the very idea of traditions and values.

If we really wanted a global village, we would *start* with the local culture, learn to live in it, share in it, appreciate it, begin to recognize what is highest in it — what expresses its noblest and most universal ideals — and then encourage *from within the culture* the development and fulfillment of these ideals.

Unfortunately, we in the technologically driven societies have failed miserably in assessing the consequences of technology for ourselves. So we're hardly in a position to offer the gifts of technology in a healthy and appropriate way to other, quite different cultures.

Individual and Community

Returning, then, to Mario Vargas Llosa: He wants to preserve the individual's freedom — with perfect reason. He also wants to protect the individual's identity against usurpation by some collectivist abstraction — again with perfect reason. After all, in a mere side-by-side aggregation or collective, the individual's identity may indeed compete with the group's.

But community is not an abstract, collectivist reality — except in the globalist thinking that Vargas Llosa seems to be supporting. Instead of a simple, mechanical opposition between individual and culture, he should have made a double statement reflecting two intertwined truths:

> First, you cannot have a cultural community — certainly not a forward-looking community in our day — unless it is founded upon the free individual.
>
> And, second, you cannot have a true individual who is cut off from community. It is through our rooted and enduring relations to those around us that we become most deeply ourselves.

Rudolf Steiner, the founder of Waldorf education, once remarked,

> The healthy social life is found when in the mirror of each human soul the whole community finds its reflection, and when in the community the virtue of each one is living.

Words like these are easily spoken, but for most of us it may require a lifetime to learn to think productively about society in such organic terms. And we never will think this way if we continue yielding passively to the influence of our machines.

I believe it's a pretty fair definition of technology to say something like this: technology consists of the machinery and the mental habits conducive to a dead thinking. (Note: "conducive to dead thinking," not "absolutely necessitating such thinking.") *(continued on p. 19)*

Craig Testifies in New Zealand

New Zealand's Royal Commission on Genetic Modification is conducting an inquiry to determine how genetic engineering should or should not be applied in agriculture and medicine. In a model process, the commission is examining many different views on the question.

Last Fall a coalition of environmental groups in New Zealand asked Craig to testify before the Commission. One of the coalition members, having read Craig's book, *Genetics and the Manipulation of Life: The Forgotten Factor of Context*, recognized that he brought perspectives not otherwise likely to be presented before the panel.

So, on February 8 Craig sat in front of a video camera at an Albany, New York studio, and spoke "live" to the Commission. (They listened to him from the "future," on February 9.) Speaking for about forty minutes, he gave many examples showing the danger of following a gene-centered program in modifying organisms. He also questioned whether transgenic "golden rice" can fulfill its widely advertised promise to help solve the world's nutritional problems.

Two lawyers, one representing the biotech industry, then cross-examined Craig for about one-half hour. Afterward, a representative from the environmental coalition wrote: "You were brilliant! It was the most perfect beginning to our presentation and your answers to the lawyers were great.... Your comments acknowledged the fact that there are some questions that are not easily answered.... You were not at all defensive or aggressive. I think that really made a difference to the commissioners."

A New Website

As you know, The Nature Institute's online newsletter, NetFuture, has its own website, provided through the extraordinary generosity of the publisher, O'Reilly & Associates: www.netfuture.org. NetFuture now delivers over 30,000 page views per month, and receives about 10,000 visitors each month. This, of course, is in addition to the distribution of the newsletter via email to 5,000 subscribers.

Now our website has been expanded to offer more information about The Nature Institute as a whole. You can check out the new pages by going to www.natureinstitute.org. There you will find a description of the Institute, our staff, and our work. The major articles from past issues of *In Context* are also available on the site, together with miscellaneous articles from other sources.

We will welcome your feedback about the overall site. It is distinctly low-tech — even primitive, you might think — but its content has been an encouragement and inspiration to many people. (Browse www.netfuture.org/people.html to see what they have said about the content.) We hope to upgrade the appearance and usefulness of the site, but are firmly determined to avoid the "noisiness," over-stimulation, and commercialism that have reduced so much of the World Wide Web to a flashy-trashy wasteland. Your reactions and recommendations will help us in the undertaking.

Three Important Articles

Michael D'Aleo and Stephen Edelglass, researchers at our sister organization, SENSRI, have written a striking paper on "Water, Energy, and Global Warming." In it they assess the climatic consequences of two largely overlooked factors: the production of water vapor — especially the high-temperature water vapor resulting from combustion of fossil fuels; and the overall human production of energy from fossil fuels and other sources. They conclude that the local and regional effects of these factors go a long way toward explaining the "conflicting" sets of data at the heart of the global warming debate.

What emerges from their discussion is that, while *global* warming may indeed remain a question, there is no doubt at all about local and even regional climate disruption associated with human activity. For example, human-related energy production in Queens County, New York, amounts to an amazing 43% of energy received from the sun, and the annual production of water vapor (with its strong insulating qualities) is so great that, if it were precipitated out of the atmosphere, it would cover the county to a depth of nearly four inches. All this helps to explain the "heat island effect" around cities. A similar effect, the authors point out, is present in areas undergoing massive deforestation, such as the Amazon basin.

You'll find an abridged version of the paper at www.netfuture.org/2001/Mar0101_118.html, and the full paper (with supporting data and references) at www.netfuture.org/ni/misc/pub/warming.html.

We introduced SENSRI and its staff in *In Context* #4. Unexpectedly, Stephen Edelglass died in November, 2000, shortly after that issue was published. We had anticipated many years of fruitful collaboration with Stephen, and are deeply saddened by his passing.

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In the January, 1999 issue of *Elemente der Naturwissenschaft* Craig published a paper on "Science as Process or Dogma? The Case of the Peppered Moth." The peppered moth, known to almost every high school biology student, is the classic textbook illustration of natural selection. There's only one problem: much of the standard story about the moth is wrong—this because researchers were much more concerned to prove a theory than to understand the life of the peppered moth. As biologist Andreas Succhantke, author of numerous books and articles on environmental science, remarked in a review, Craig shows

> in a concrete example that apparently secure knowledge, which is a fundamental support of evolutionary theory and has found its way — via textbooks — into our heads, is in reality built on sand.

Craig's paper was published in abridged form in *Whole Earth* (Spring, 1999). Now the original paper is also available at The Nature Institute's website: www.netfuture.org/ni/misc/pub/moth.html.

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Craig's comparative study of the horse and the lion is available at www.netfuture.org/ni/misc/pub/horselion.html. Entitled "Seeing the Animal Whole: The Example of the Horse and Lion," the essay is a chapter in *Goethe's Way of Science*, edited by David Seamon and Arthur Zajonc and published in 1998 by SUNY Press. The chapter is reprinted (for a limited time) on our website by permission of SUNY Press.

Reaching Out

Craig and Steve continue an active schedule of lecturing, conducting workshops, and writing articles for publication. Here are a few snapshots of this activity.

Defending a nature-based agriculture. The editors of *Sierra* magazine have put together a special section on biotechnology for their July/August issue, and Steve and Craig have co-authored the anchoring feature article for the issue. Their essay looks at biotechnology in general and genetic engineering in particular as factors in the progressive fragmentation of agricultural and environmental contexts. Our choice today is between working with nature so as to discover the productive potentials of a healthy biodiversity, or else supplanting nature with monocultures and with increasingly factory-like systems of production. As the article puts it:

> Nature manifests itself ecologically — contextually — and the whole point of today's advanced crop production is to uproot the plant from anything like a natural, ecological setting. This, in fact, is one of modern agriculture's boasts. The latest technology delivers, along with the seed, an entire artificial production environment designed to render the crop independent of local conditions. Commercial fertilizer substitutes for the natural fertility of the soil. Irrigation makes the plants relatively independent of the local climate. Insecticides prevent undesirable contact with local insects. Herbicides discourage social mixing with unsavory elements in the local plant population.
>
> Modern agribusiness is run more and more like a self-contained factory. And the trend toward monocultures — where entire ecologies of interrelated organisms are stripped down to a few, discrete elements — has become more radical step by step: first a single crop replacing a diversity of crops; then a single variety replacing a diversity of varieties; and now, monocultures erected upon single, genetically engineered traits.

Goethean perspectives on evolution. Last October The Nature Institute co-sponsored a symposium on evolution in cooperation with the Center for the Study of the Spiritual Foundations of Education, Teachers College, Columbia University. The aim was to look at evolutionary development in the light of the Goethean notion of the organism's "type" (or "archetype"). A key question was, How does one reckon with the inner, constitutive law of the organism, and not merely with the outer circumstances (including genetic and environmental circumstances) to which the organism responds?

The idea of the type would, of course, be written off by most biologists as an otherworldly, "Platonic" notion. The conference participants, while themselves skeptical of static and abstract concepts, also felt the inadequacy of contemporary Darwinian theory, with its tendency to analyze the organism into discrete traits. Such an approach, in which the organism is derived from genes and environment, loses sight of significant relations between organs within an organism, and between different species or groups of plants and animals. The lawfulness one sees when looking at these relations has, as Craig pointed out, "a fluid, malleable character and is what actually allows us to see in an animal more than just separate traits."

The two-day conference, intense and productive, was a preliminary exploration of the issues, grounded in a concrete look at birds and dinosaurs, among other topics. The gathering exemplifies our aim of bringing scientists together to work specific topics.

As a presenter, Craig was joined by Mark Riegner, an ecologist and professor of environmental studies at Prescott College in Arizona, Martin Lockley, a dinosaur expert in the geology department of the University of Colorado, Johannes Wirz, a molecular biologist at the Goetheanum in Switzerland, and Ronald Brady, a professor of philosophy at Ramapo College in New Jersey.

Past and forthcoming. Here, briefly, are some other developments from the past half year, and a few things to look forward to:

- The Spring, 2001 issue of *Worldviews: Environment, Culture, Religion* carries Steve's review of *Goethe's Way of Science: A Phenomenology of Nature*, edited by David Seamon and Arthur Zajonc.
- Steve has also written a chapter for a book to be published by Springer Verlag in conjunction with the forthcoming Cognitive Technology 2001 conference in Warwick, U.K. We'll provide more information later.
- In January Craig gave a lecture and workshop at the Spring Hill Waldorf School in Saratoga Springs, New York. In the workshop he focused on the organism's wholeness; the preceding evening lecture addressed genetic engineering applications in agriculture.
- In February Craig participated in the conference, "Education towards Freedom: The Mission of the Waldorf High School," at the Hartsbrook School in Hadley, Massachusetts. His workshop, entitled, "Grasping the Whole: Science Education for the Twenty-first Century," developed the idea of science as a participatory process.
- Steve's plenary address to the "Technology and Globalization Teach-In" in New York City is contained in this issue of *In Context*. He also participated in three panels at the Teach-In, dealing with virtual reality, the idea of a global mind, and the question whether the networking of the world serves to centralize or decentralize power.
- From August 6 to 9 Steve will attend the Cognitive Technology 2001 conference in Warwick, U.K., where he will deliver a keynote address on the relationship between computers and minds.
- On May 18 and 19, Craig will deliver a talk and workshop entitled, "Enlivening Our Perception and Understanding of Nature," in Minneapolis/St. Paul, Minnesota. For further information contact The Nature Institute at 518-672-0116.
- On May 26 Craig will conduct a workshop with biodynamic farmer, Hugh Williams, at the Pfeiffer Center, Spring Valley, New York. The workshop will deal with genetic engineering and seed saving. For further information contact The Nature Institute at 518-672-0116.
- From July16 to 20 Steve will teach a one-week course at the Rudolf Steiner Institute in Waterville, Maine. The course deals with the fundamental challenge of technology to humanity. For more information about the Institute's course offerings and registration, see www.steinerinstitute.org or call 301-946-2099.

Arrival and Departure

Penelope Lord (right) our capable office assistant since the Institute's founding, has left to pursue interests closer to her home in Great Barrington, Massachusetts. Jessica Hamilton, a parent at the Hawthorne Valley School across the street from the Institute, has now stepped into the void, taking on an expanded, half-time office-assistant role. We wish Penelope well in her new undertakings, and are already enjoying Jessica's enthusiastic participation in our work.

We are also pleased to welcome our friend and colleague, Johannes Kühl to our advisory board. Johannes is a physicist and the head of the Science Section at the Goetheanum in Dornach, Switzerland. In Johannes we have a true co-worker in trying to develop a phenomena-centered science. He has been a supporter of the Institute since its founding, and we also collaborate in work of the Science Section.

The Institute Enters a New Phase

A Word from the Board of Directors

The Nature Institute is embarking on a critical second phase of its development. In the three years since its founding in 1998, the Institute has firmly gained its footing in the scientific community while carrying just a portion of the economic burden an institution usually bears. This has been possible through a strong partnership between (1) the contributors and friends who have valued and generously supported our work; and (2) the committed researchers who, while working full-time, have taken only half-time salaries, making up the financial difference with other part-time work.

In the meantime, The Nature Institute has responded to an increasing demand for its resources, confirming our conviction that a phenomena-centered approach to science provides answers to some of the most pressing issues of our time. Yet, meeting the workload has stretched the researchers to their limits. Everything has pointed to the need for us to take a further step.

We recognize that The Nature Institute has now grown to a new level, requiring the full attention of the researchers. Accordingly, Craig and Henrike have resigned their combined teaching position at Hawthorne Valley School, and both Craig and Steve have accepted the risk of committing themselves solely to the Institute, giving up their outside responsibilities. We in turn are committed to providing them with the financial means to do this.

So, as we move into our second phase of development this year, the annual operating budget will double to $180,000. This reflects the true expenses of an established institution, with two full-time researchers, a part-time associate, a half-time assistant, expanded office space, a print publication (*In Context*) with rapidly expanding circulation, research and project materials, and computers and other necessary office equipment. Clearly, we must expand and strengthen our circle of supporters who are partners with us in this work. Based on the continuous stream of positive responses that have helped establish The Nature Institute, we're confident we can take this new step. We have also begun the process of expanding our Board of Directors.

A major challenge grant to The Nature Institute is currently being developed, and we hope to give you more details soon. In the meantime, any extra support you can offer, directly or indirectly, to set us on our way in this new phase will be very much appreciated. If someone you know would like a copy of *In Context*, please inform us. Thank you very much for helping us grow to this point!

Teresa Woods Barnes, for the Board of Directors

Thank You!

We would like to extend special thanks to the following persons who have contributed money, goods, or services to The Nature Institute (or its online publication, NetFuture) between October, 2000, and the end of March, 2001.

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Anthroposophical Society of America
Berkshire-Taconic Community Foundation
Hudson River Bank and Trust Foundation
Rudolf Steiner Charitable Trust
Software Stiftung
Shared Gifting Group of the Mid-States (Rudolf Steiner Foundation)
Waldorf Educational Foundation

Elephantine Intelligence

Craig Holdrege

This article is a section of a monograph on the whole-organism biology of the elephant that we will publish later this year in our new "Nature Institute Monographs" series.

THE ELEPHANT is well known for its intelligent behavior. Let's look at various examples of non-trained elephant behavior:

> If he cannot reach some part of his body that itches with his trunk, he doesn't always rub it against a tree: he may pick up a long stick and give himself a good scratch with that instead. If one stick isn't long enough he will look for one that is. (1, p. 78)
>
> On many occasions I have watched an elephant pick up a stick in its trunk and use it to remove a tick from between its forelegs. I have also seen elephants pick up a palm frond or similar piece of vegetation and use it as a fly swatter to reach a part of the body that the trunk cannot. (2, p. 139)
>
> If he pulls up some grass and it comes up by the roots with a lump of earth, he will smack it against his foot until all the earth is shaken off, or if water is handy he will wash it clean before putting it into his mouth. (1, p. 78)
>
> Elephants have picked up objects in their environments and thrown them directly at me, undertrunk, with surprising, sometimes painful, accuracy. These projectiles have included large stones, sticks, a Kodak film box, my own sandal, and a wildebeest bone…. Elephants have been known to intentionally throw things at each other in the same circumstances: during escalated fights and during play. Elephants have been known to intentionally throw or drop large rocks and logs on the live wires of electric fences, either breaking the wire or loosening it such that it makes contact with the earth wire, thus shorting out the fence. (2, p. 139)
>
> [In India an] elephant was following a truck and, upon command, was pulling logs out of it to place in pre-dug holes in preparation for a ceremony. The elephant continued to follow his master's commands until they reached one hole where the elephant would not lower the log into the hole but held it in mid-air above the hole. When the mahout [elephant driver] approached the hole to investigate, he found a dog sleeping at the bottom; only after chasing the dog away would the elephant lower the post into the hole. (3, p. 137)
>
> [In South Africa] it was observed that an elephant, after digging a hole and drinking water, stripped bark from a nearby tree, chewed it into a large ball, plugged the hole, and covered it with sand. Later he removed the sand, unplugged the hole, and had water to drink. (3, p. 137)
>
> Many young elephants develop the naughty habit of plugging up the wooden bell they wear around their necks with good stodgy mud or clay so that the clappers cannot ring, in order to steal silently into a grove of cultivated bananas at night. There they will have a whale of a time quietly stuffing, eating not only the bunches of bananas but the leaves and indeed the whole tree as well, and they will do this just beside the hut occupied by the owner of the grove, without waking him or any of his family. (1, p.78)

As we can see from these examples, intelligent behavior allows the animal to deal with a concrete situation in a flexible and non-schematic manner. Or as Shoshani and Eisenberg put it, intelligence is "the capacity to meet new and unforeseen situations by rapid and effective adjustment of behavior" (3, p. 134). Intelligence presupposes an ever-present ability to learn. Not unexpectedly, many of these examples show that the elephant's intelligence often manifests through the activity of the trunk: breaking off sticks that are then handled as an extended limb to scratch or swat with; throwing with the trunk; stuffing a bell with the trunk. With such a flexible and dexterous prehensile organ, how could an elephant not be intelligent?

At the same time, these activities involve the whole animal in the coordinated use of different body parts and senses: sight and trunk are used in throwing, while foot and trunk coordination allows cleaning clumps of grass. Raman Sukumar describes a scene that clearly illustrates the elephant's complex behavior:

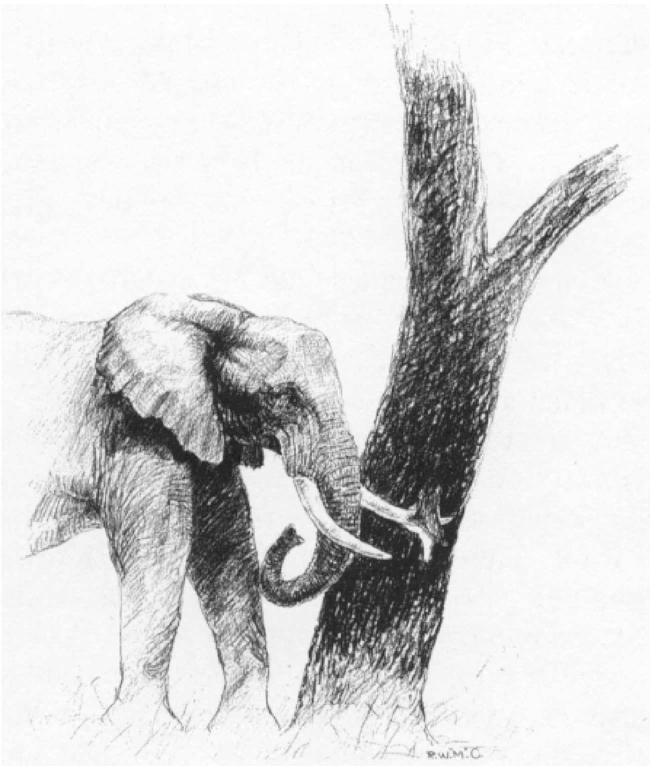

Figure 1a. An African elephant gouges a tree, loosening the bark.

Figure 1b. The elephant grabs the looosened bark with its trunk and pulls upward.

Figure 1c. Enwrapping the strip of bark with its trunk, the elephant pulls downward tearing off the strip.

(Drawings by R.W. "Mike" Carroll, from *Elephant Life* by Irven O. Buss. Copyright 1990 Iowa State University Press, Ames, Iowa 50010; reprinted with permission.)

> Vinay [a solitary adult Asian elephant bull] poked at the *bendai* tree with his left tusk, thrusting it up into the gash and splitting the bark. He grasped a portion with his trunk and tugged expertly with an upward flick, tearing off a four metre long strip. Another tug and the strip broke loose from the tree-trunk and came down. Vinay now began eating the bark, skillfully using his forefeet and trunk to break off small strips before transferring them to his mouth.
>
> After feeding for some ten minutes, Vinay did something that only an elephant can do so effortlessly. He turned towards the tree, and using his fore head and trunk, pushed the tree over. In a minute or so the tree was cleanly uprooted. Vinay tore just one more strip of bark from the tree and then turned away. Almost nonchalantly he began to pluck green grass that sprouted profusely from among burnt clumps. As he wrapped his trunk around a clump and pulled, the tender leaves came off quite easily from their dry bases. Stuffing one trunkful after another into his mouth, Vinay ambled along at a gentle pace. (4, p. 50)

The elephant's behavior flows from one activity to the next, engaging its brawn and dexterity as needed. The key to such actions and their sequence is that they are not automatic and prescribed. Intelligent behavior expresses plasticity– flexible interaction with experience. The elephant

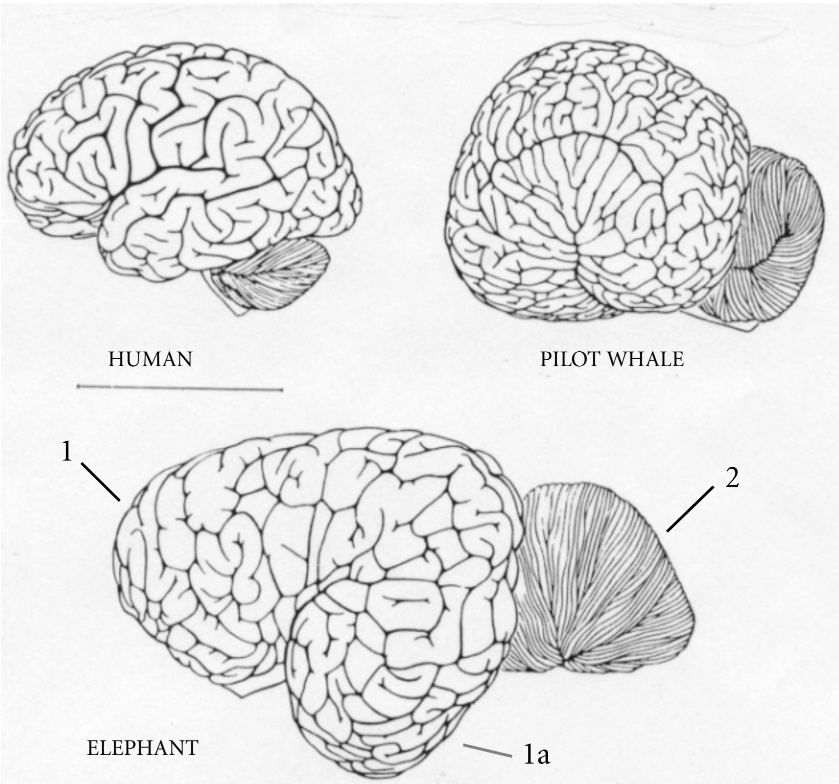

Figure 2. Brains of human being, pilot whale and elephant, viewed from the side. Drawn to scale (bar = 10cm). (1) cerebrum. (1a) temporal lobe of cerebrum. (2) cerebellum.

(From 5. Copyright 1970 by Springer-Verlag. Reprinted by permission.)

cleans off the dirt by smacking the clump of grass against the foot, but if it also perceives water nearby, it can then take the clump and submerge it in water to clean it further. It doesn't just have one "built-in" way to carry out tasks.

All the above examples reveal what we would call purposive behavior. We have to be very careful here not to anthropomorphize an animal's behavior. We'd clearly be anthropomorphizing if we imagined an elephant scheming about how to steal bananas and coming up with the idea of plugging the noisy bell. That's just putting a human mind in elephant skin. Also, in the case of the elephant that did not put the log on the dog, we shouldn't immediately assume that the elephant took pity on the dog or that it had a conscious awareness that it was about to kill the dog. Such caution does not detract from the impressive act itself. Rather, it leaves us more open. We erase the possibility of understanding the elephant's unique kind of intelligence if we too easily read our own experience into it. When we stay close to the perceived situation and hold back with judgments, the unique and fascinating qualities of the animal become *more* vivid than if we imagine it in our own terms. We don't, after all, merely want to mirror ourselves in the animal.

THE SCIENTIST Herbert Haug carried out a detailed comparative study of the anatomy of the elephant, dolphin and human brains to see if he could find out how the brains might relate to the intelligent behavior of these creatures (5). The brains differ distinctly from one another, but all are large (see Figures 2 and 3). The elephant has the largest brain of all land animals; an adult elephant's brain weighs on average between nine and twelve pounds. But, of course, the elephant also has the largest body of all land animals. The elephant's brain makes up about 0.08 percent of the total body weight, while a horse's makes up about 0.25 percent of its total body weight. The human brain weighs three to four pounds and is also relatively large, making up two percent of our body weight (6, p. 108).

The brains of elephant, dolphin, and the human being are all highly convoluted, which increases the surface area of the brain. These brains exemplify the well-known correlation between the degree of brain folding and the degree of intelligent, flexible behavior found in mammals.

But what is specifically elephantine about the elephant's brain? Three areas of the brain are noticeably enlarged (absolutely and relatively): the olfactory lobe, the cerebellum, and the temporal lobe of the cerebrum (see Figure 3). Enlargement of part of the brain usually means that there are more neurons in that part of the brain. These neurons are connected to other parts of the brain and to the rest of the body via nerve fibers. The enlargement of the olfactory lobe is clearly connected to the fine innervation of the sense of smell in the trunk. The cerebellum has been found to be related to muscle coordination in other, better researched mammals. Since the nerve pathways in the elephant are not that well known, Haug can only make the clearly reasonable suggestion that the cerebellum's high degree of development is related to the highly coordinated trunk movements. As the focus of so many of its activities, it is not surprising that the elephant's intelligence-imbued trunk is mirrored in the enlargement of parts of the brain connected to the trunk.

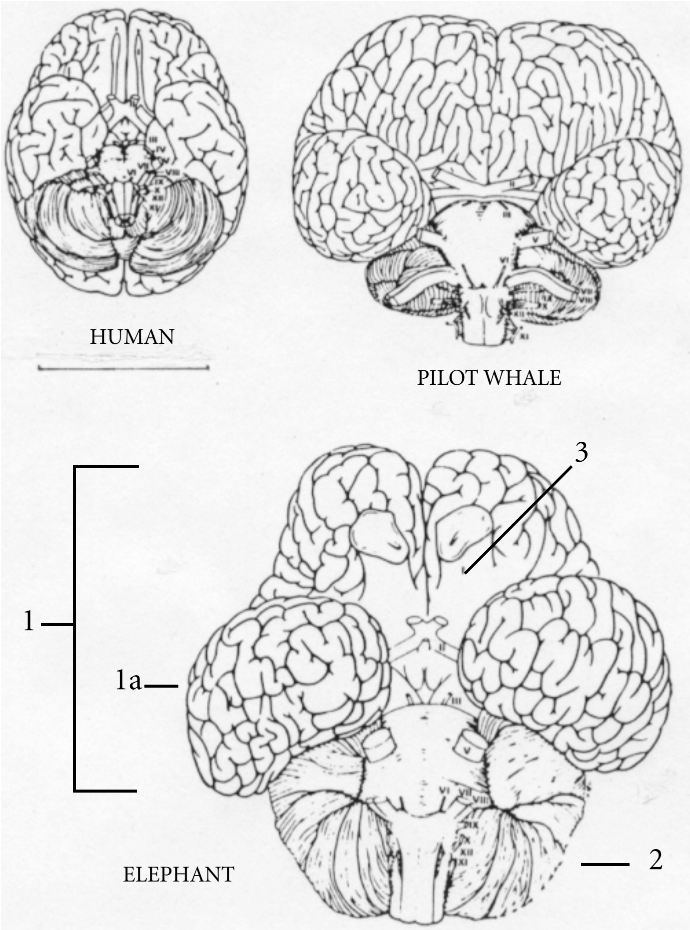

Figure 3. Brains of human being, pilot whale, and elephant, viewed from below. Drawn to scale (bar = 10 cm). Note the very large temporal lobe (1a) of the elephant brain. Roman numerals indicate cranial nerves. The olfactory nerves leading to the trunk (3) are especially developed in the elephant. (1) cerebrum. (2) cerebellum.

Why the temporal lobes are so large (proportionately larger than in any other mammal), remains a riddle. The temporal lobes are generally related to hearing in mammals (and speech in the human being), so it seems reasonable to conjecture that the elephant's ability to distinguish and communicate through a variety of sounds (including infrasound) may well be connected to the differentiation of the temporal lobes.

Haug's study led him to be skeptical about any claims that correlate intelligence and the brain too closely:

> From a qualitative point of view, the human being does not possess—compared to elephants and dolphins—a particularly high grade of cerebral differentiation that would provide the morphological basis for such a great difference in intelligence as is actually present…. The question must be asked, whether brain differentiation must necessarily be equated with human productive intelligence" (5, p. 56).

There is a strong tendency in our times to want to localize intelligence — and other capacities — in the brain. It's a very unorganismic way of viewing that leads us to seek for a "command center" in the brain. Intelligence resides just as little (or just as much) in the brain as it resides in the elephant's trunk. It would be just as correct (or incorrect) to say that the elephant has its center of intelligence in the trunk as it would be to say that it's in the brain. If the elephant's trunk becomes lame, some of its intelligent behavior will be missing, just as when part of its brain is dysfunctional. In either case it could compensate for such injuries to a certain degree by engaging other body and brain parts. Intelligence resides everywhere and nowhere. Perhaps it's best to say we discover it in the intelligent activity itself, which is carried out and made possible by the *whole* animal. And in the elephant this whole is most vividly embodied in the use of the trunk.

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Life Beyond Genes

Reflections on the Human Genome Project

Craig Holdrege and Johannes Wirz

During the 1990s molecular biologists were fully engaged in a race to determine the complete DNA sequence in various organisms. And they succeeded — first in bacteria, then in yeast, and finally in a well-researched roundworm (*C. elegans*). In early 2000 the DNA sequence of the fruit fly, the genetic workhorse of the twentieth century, was completed. In June, 2000, at the White House amid media fanfare, two genome sequencing teams announced that they had completed a "working draft" of the human genome. Their reports were published in February, 2001 (1,2). The mega-project was at an end — or was it actually just the beginning?

"Another Century of Work"

In 1991 geneticist Walter Gilbert made a brash statement: "I expect that sequence data for all model organisms and half of the total knowledge of the human organism will be available in five to seven years, and all of it by the end of the decade" (3). With regard to sequencing, Gilbert was astoundingly close in his conjecture. At that time almost no one believed the feat could be accomplished in only ten years. But technical advances in automated, rapid sequencing, along with more powerful supercomputers and software, helped accelerate the genome work. The competition between the two genome teams, one privately and one publicly funded, was also a major driving factor.

But Gilbert saw more in the sequence completion than virtually endless strings of letters on a computer screen, representing nitrogenous bases in DNA. He spoke of gaining "total knowledge of the human organism." This statement reflects a tendency — one that seemed to accelerate in stride with gene-finding — to make overblown claims about the genome work. We might expect such hyperbole from the media seeking the hottest stories, but the scientists involved in the work were often the worst transgressors of measured assessment. The genome project was, in the words of the public-team leader, Francis Collins, "the most important and most significant project that humankind has ever mounted" (4). Why? Because it meant opening what he, like many others, called "the book of life," a book that reveals the secrets of the human being. "For the first time," stated biologist Robert Weintute, "we are reducing ourselves down to DNA sequences…to rather banal biochemical explanations….We are dealing with the mystery of the human spirit" (5).

When the *New York Times* announced in its June 27, 2000 headline that "Genetic Code of Human Life is Cracked by Scientists," the lead article proclaimed: "In an achievement that represents a pinnacle of human self-knowledge, two rival groups of scientists said today that they had deciphered the hereditary script, the set of instructions that defines the human organism." Interestingly, at this pinnacle of fervor concerning the project, some scientists were markedly more circumspect in their comments. Molecular biologist David Baltimore remarked, "we've got another century of work to figure out how all these things relate to each other" (6). Another scientist spoke of the genome as an "internal scaffold for our existence" (7). And still another stated, "It's like a book in a foreign language that you don't understand. That's the first job, working out the language" (quoted in 8).

These scientists are telling us that the genome project was actually just the beginning of real understanding. It is, after all, one thing to find a scaffold or a book that you haven't even begun to decipher (and we should remember, in applying the book metaphor, that a book is not the thing itself, but only a reference to the actual content). It is a wholly different matter to gain knowledge of the actual workings of the living organism, not to mention self-knowledge and finding a key to "the mystery of the human spirit."

So was the genome project just caught up in one big jamboree of hype? In many ways, yes. In a letter to the editor of *Nature*, written before the completion of sequencing was announced, scientist Sol Hadden puts his finger on some essential issues:

> Current hype about the expected completion of the Human Genome Project demands some clarification. Although initially conceptualized more broadly, the project is effectively about determining the sequence of bases in the human genome. This is not the same as trying to understand the program that is encoded in human DNA. Consequently, the results will be in the merely descriptive naturalistic tradition. Technical development has always had that effect on scientific

> disciplines, for example the electron microscope, the radio telescope or the automated DNA sequencer.
>
> Of course, researchers are always quick to emphasize the importance of their work to whatever application is in vogue, and curing disease is a worthy goal. But how will the Human Genome Project help to achieve this end? A look at any [gene map] from any species reveals what looks like an explosion in a slaughterhouse. Where is the order we need, to make sensible rather than trial-and-error genetic manipulations?
>
> In any case, pharmacogenomics [using genetics to make medicines] requires an understanding of the apparent genetic 'disorder' in any organism's genome, of genotype-phenotype mapping, of gene-gene interactions, of intraspecific genetic variability, and of self-organizational processes, rather than endless lists of DNA bases. (9)

In other words, the human genome project really serves to show how little we know. And we could have realized all along — if hype did not have such a strong pull on us — that reams of data (2000 New York City telephone books' worth) would not tell us much. The real challenge is to understand genes in the context of the living organism and not to connect this endeavor with the expectation that such knowledge will open up the secrets of life.

Only 30,000 Genes?

One of the most intriguing conclusions that both genome sequencing teams drew from their data was that the human genome contains only about 30,000 genes (1,2,10). For a decade scientists have been speaking of approximately 100,000 human genes. The small number was unexpected because far less complex organisms have nearly as many genes. The roundworm (consisting of a total of 959 cells!) has about 20,000 genes, while the mustard plant *Arabidopsis* has about 25,000. If, as the story goes, genes make an organism, how can it be that we — with our complex internal organs and physiology, not to mention behavior — have such a small number of genes?

The real question is, however, why did anyone think that genes make an organism what it is in the first place? As biologist Svante Pääbo comments, successes in the last decade

> have resulted in a sharp shift toward an almost completely genetic view of ourselves. I find it striking that 10 years ago, a geneticist had to defend the idea that not only the environment but also genes shape human development. Today, one feels compelled to stress that there is a large environmental component to common diseases, behavior, and personality traits! There is an insidious tendency to look to our genes for most aspects of our "humanness," and to forget that the genome is but an internal scaffold for our existence. (7)

What is so strange about the genocentric view is the fact that the genetic discoveries themselves don't actually support it. The results are simply being viewed through a deterministic and materialistic lens.

Genes and Development

During the past fifteen years the role of genes in development has been studied intensively and can help shed light on the relation between an organism and its genes.

In 1994, Walter Gehring's research group in Basle, Switzerland, discovered that the human being, mouse, and fruit fly all have a gene — called *Pax 6* — that is not only very similar (homologous) in each species, but is also related to eye formation (11). This came as a surprise, since the eyes of mammals and insects are totally different anatomically. No one expected the "same" gene to be related to such different structures.

The apparent connection between the *Pax 6* gene and eye development became more compelling when researchers were able to manipulate fruit flies to express the *Pax 6* gene in tissues that would normally become wings, legs, and antennae (12). The result was wholly abnormal fruit flies with partial eyes growing on their legs and wings and even on their antennae. In compensation, these parts often did not develop fully. The scientists then proceeded to do the same experiment with the homologous *Pax 6* gene from the mouse. The fruit flies again made eyes — fruit fly-type and not mouse-type — on other body parts. The same experiment succeeded with *Pax 6* genes from sea squirts and squids. Gehring concluded that they had clearly discovered and demonstrated the existence of a "master control gene" for eye development (12,13).

But, as is usually the case in biology, the story and the conclusion are not so straightforward. Since the *Pax 6* gene is in yet unknown ways functional in animals without eyes, like roundworms and sea squirts, it is clearly not related to eye development in these organisms. In other organisms it is also connected to different developmental processes. Mutant mice with two copies of the altered *Pax 6* gene not only have no eyes at all, but they have malformed noses, cannot breathe, and die. In squids the gene is active in tentacle formation. In the fruit fly it is involved in the development of other parts of the nervous system beside the eye, and if the *Pax 6* gene is not expressed at all in mutants, they die. And in the fish-like lancelets (amphioxus), it is related to the development of olfactory and central nervous system tissue.

So, it seems that, in each organism where it has been found, the "master control gene" for eye development is involved in processes other than eye development. Within a particular organism it is active at different places and at different times, depending on the organ or tissue that is forming there and then (see Figure 1). Evidently, it's not just the gene that determines the function.

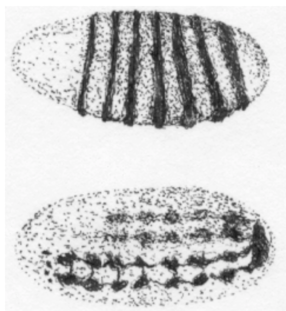

Figure 1. One gene, different functions. The *FTZ* gene in the fruit fly is needed to form a particular protein (the fushi tarazu protein). But the gene and this protein have more than one function during the fly's embryonic development. The drawings show two fruit fly embryos, one at an earlier (top), the other at a later stage of development (bottom). The dark stripes and blotches represent the *FTZ* protein, which was made visible by staining. In the earlier stage (top) this protein is expressed in bands and active in the formation of segment boundaries; it is then broken down. Only three hours later (bottom), the protein is formed anew and is involved in the development of nerve cells. Thus the *FTZ* gene is first a "gene for" segment development and then a "gene for" nerve cell development. (Redrawn from 14)

The Resourceful Organism

One finds many examples like this in the study of developmental genes: First a gene is discovered in a particular organism within a particular experimental and developmental context. Then this "same" gene is discovered in other organisms and usually has at least some similar functions. The more the gene is researched, the more it turns out to be implicated in various development processes. In the end, the "same" gene has neither a common function among different species, nor only one function within a single species.

This fact led Denis Duboule and Adam Wilkins to use the term, "bricolage," to express how the organism uses what is genetically at hand to realize its own specific development. They expect that "the primary source of developmental differences between fruit flies and foxes will prove to be not unique genes but rather the way that comparable, or the same, gene functions are differently deployed in their development" (14).

A recent experiment illustrates this fact clearly (15). The lancelet (amphioxus) is a close relative to the vertebrates and is often used to depict how the evolutionary ancestor of vertebrates might have appeared. It is a small fish-like creature that has, however, no bony skeleton and no paired fins (see Figure 2). Its front end is pointed, and biologists don't speak of a head because typical head features, like brain and brain capsule, developed sense organs, or a jaw, are missing.

Scientists have found a group of developmental genes, called the *Hox* genes, that are related, among other things, to the formation of head structures in vertebrates. These *Hox* genes were also discovered in the lancelet, and since it is has no head, these genes must be related to other, up till now unknown, processes in lancelet development. When, however, the sequences that regulate lancelet *Hox* gene expression were implanted into mice and chick embryos, they turned out to control genes in *head-forming* tissues. This means that a DNA sequence with specific functions in one organism can be utilized by another organism to form completely different tissues and organs.

Both this and the "eye" gene example show us that genes don't make the organism. What a gene "is," is dependent on the organism in its spatially and temporally unfolding existence. You always have to presuppose the organism to understand the gene. This conclusion has far-reaching implications.

Take, for example, our conception of evolutionary processes. The scenario taught in schools and universities around the world is: The gradual accumulation of gene mutations causes organisms to evolve new characteristics. But this scenario doesn't work, if we take the results of developmental genetics seriously. Rather, we must imagine the evolving organism utilizing "old" genes in new ways to realize new evolutionary developmental characteristics. This view removes genes from their pedestal in evolutionary theory, since they can no longer be seen as the driving evolutionary force. The whole organism — which has been virtually lost in genetic and evolutionary thinking today — returns to the center stage of development and evolution.

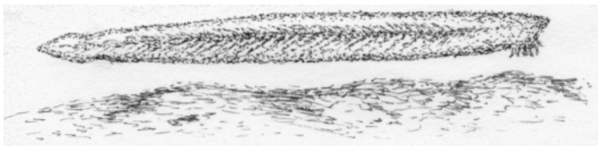

Figure 2. The lancelet (amphioxus) is a fish-like animal that dwells in coastal waters and burrows into sand. About two inches long, it feeds by straining small organisms out of the water.

Genes and Human Traits

> The work on viruses and bacterial cells that gave birth to molecular biology in the 1940s and 1950s significantly strengthened the earlier notion of "one gene, one function" of early mendelians. Furthermore, in recent decades, geneticists and molecular biologists have inadvertently contributed to this misconception by the ways they name their genes based on how they were first identified — breast cancer genes, growth factor genes, and so on. This semantic imprecision has had an unfortunate effect on public perception of gene action: many lay people apparently believe that phenotypic traits, such as blue eyes or obesity, are due to the exclusive function of particular genes…. Explicit recognition of the general rule of multiple use of specific regulatory gene products would help to clarify issues in both development and evolution. (14, p. 56)

Just as the 1990s were the decade of genome sequencing, so also were they the decade in which hardly a day went by without an announcement of the discovery of a new gene determining some trait: longevity, happiness, day-night rhythm, alcoholism, schizophrenia, sex drive, Alzheimer's and even IQ. It's no wonder everyone believes that we're determined by our genes.

But if the working of genes is complex and subtle, as the research we've described shows, then something must be awry in the claims about finding genes "for" this or that trait. Geneticists Neil Risch and David Botstein wrote a commentary in *Nature Genetics* in 1996 describing the search for the gene for manic depression (16). They found that over the previous twelve years sixteen different research groups had announced the discovery of genetic linkages to manic depression (which translates in popular language into "gene for manic depression"). The problem — from a "one-gene, one trait" perspective — was that these researchers identified *fifteen* different locations for the gene on *eleven* different chromosomes! Not lacking in humor, Risch and Botstein state that "one might argue that the recent history of genetic linkage studies for this disease is rivaled only by the course of the illness itself." They see the lack of consistency as an expression of the complexity of the illness on the one hand and not enough rigor in statistical analysis on the other. Evidently, the urge to find a genetic cause often overshadows the recognition of the complex nature of the phenomena.

As we have described elsewhere, even diseases that follow a more straightforward Mendelian pattern of inheritance, like sickle-cell anemia, are complex when looked at more carefully (17). It doesn't take much investigation to find that all of the characteristics or diseases listed above — none of which follow a Mendelian pattern — are strongly related to individual and environmental factors, as well as having some hereditary component.

The problem is that the isolation of a genetic factor is always based on a narrow theoretical and experimental framework. Or to put it in Kurt Goldstein's terms, genetics works with the method of isolation and therefore produces results that are valid only within that framework (18). Take the example of amphetamine susceptibility. Scientists discovered that two different inbred strains of mice showed a very different relation to amphetamines: strain C mice preferred the box where it received injections of amphetamine, while strain D mice avoided this box (19). You can already picture the headlines: "Scientists prove amphetamine addiction is hereditary." (How often we read such articles only to discover that what we thought was a report about a human condition turns out to be an experiment with rats or fruit flies!)

But in this case the scientists were very careful and performed an additional experiment: they gave the mice less food over a period of time, while continuing amphetamine injections. Something unexpected occurred: Strain D mice began to prefer the injection box, while the previously "addict-type" strain C mice *avoided* the box. A total reversal of the results! This example illustrates drastically what, in fact, is generally the case: a "fixed genetic predisposition" may actually be only one of many appearances (phenotypes) of an organism, and this particular appearance depends largely on the specific experimental and environmental circumstances under which the trait was observed.

Tinkering with Ourselves

The dumbing-down of society to a community of believers in genetic determinism is, by itself, bad enough. But every worldview also has its practical effect on human action. The more we believe that genes determine our physical and mental constitution, the more we will be willing to tinker with those genes to change characteristics.

And this will occur in the name of human rationality. In 1998 a group of scientists met to discuss genetic manipulation of human beings, and the proceedings were published two years later (20). The participants promoted the view that science must progress and that genetic modification of human beings is inevitable. "Science proceeds and succeeds by doing….what we're talking about here are incremental advances with enormous implications" (20, p. 80). James Watson, the co-discoverer of the double-helix model of DNA and the first head of the Human Genome Project, made the following comment:

> Some people are going to have to have some guts and try germline therapy without completely knowing that it's going to work…. And the other thing, because no one has the guts to say it, if we could make better human beings by knowing how to add genes, why shouldn't we do it? What's wrong with it? Who is telling us not to do it? I mean, it just seems obvious now…. If you could cure what I feel is a very serious disease — that is, stupidity — it would be a great thing for people who are otherwise going to be born seriously disadvantaged. We should be honest and say that we shouldn't just accept things that are incurable. I just think, "What would make someone else's life better?" And if we can help without too much risk, we've got to go ahead. (20, p. 79)

Watson is known for his blunt statements, revealing, we believe, a widespread sentiment that other scientists share, but don't dare to express: the path of genetic engineering leads to the human being, and we shouldn't close our eyes to this inevitable fact. The real challenge, in this view, is to convince the public. The book's editors, scientists Gregory Stock and John Campbell, write:

> To think rationally about ethical issues in germline engineering requires basic understanding of inquiry-based analysis and general scientific (biological) background…. If all scientists were to make a commitment to improving K-12 science education in their local communities, we might eventually have a society capable of thinking analytically and rationally about the challenges and opportunities of science — including germline engineering. (20, p. 24)

In other words, people are not smart enough to see where science needs to take humanity. If we could get all elementary school children to isolate genes, middle school children to sequence them, and finally high school students to manipulate organisms with the genes, then we'd have the proper preparation. Of course, all learning about living organisms in their natural habitats would have to be dropped to provide space for such a high-tech curriculum. This would be the way to further "rational thinking."

In reality, what Stock and Campbell are aiming at is indoctrination in reductionism, so that people will lose the capacity to see through the weak and outlandish arguments of a Nobel laureate like James Watson. It's astounding that we've come so far that being rational is equated with tearing a narrow, genetic segment from the fabric of life and treating it as though it were everything. You're rational if you restrict yourself from seeing how your sector of knowledge relates to a larger whole.

As we have shown, the results of modern genetics are shouting at us to wake up and see that we've got to start taking the whole organism seriously and view genes in light of the organism and not only the other way around. Genetics began by defining genes in relation to a particular trait, ignoring the experimental and conceptual framework, and also ignoring the organism as a dynamic, changing entity. Now the emphasis should be on *how* an organism utilizes its genes within this broader context. Goethe would be happy, knowing that even the paramount reductionist science is showing — if not consciously recognizing — that he was right in emphasizing the "how" of nature and not just the "what."

But the reductionist path is well worn and deeply entrenched. Once you're in it, it's hard to climb out. It's not easy to break out of habits and change an inner direction. It means giving up the security that comes with focusing on our own particular program that biases the mind from the outset. ("Understanding an organism means reducing its functions to underlying mechanisms.") Instead, our focus needs to be on entering the richness of the phenomena themselves and changing our viewpoints in order to do justice to what we discover. Instead of barraging the world with a monologue, we enter into conversation with it. How else can we hope to find deeper understanding and responsible ways of acting?

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(continued from p.4) Examples of such thinking are everywhere. We build mechanical connections between people and we call that the "infrastructure of community." We convert the natural world into massive data sets, and we call that "ecological understanding." We send trillion-dollar capital flows streaming daily through the world, seeking nothing more than their own mathematical increase, and we call that "social development." This is machine thinking.

The English philologist and historian, Owen Barfield, has pointed out how our medieval forebears enthusiastically elaborated the possibilities of logical judgment. Not coincidentally, medieval society was hierarchical in structure. Social hierarchy is a kind of outward embodiment of logical classification. That's why the principle of hierarchy could hardly be disputed during the medieval era; it seemed as self-evident as the necessary logical structure of one's own thinking. Barfield goes on to suggest that we will reap only chaos if our new, democratic social forms are not as self-evidently grounded in the developing strength of a living imagination, as the old ones were grounded in the strength of logical judgment. When, through the power of imagination, the whole community finds its reflection in the individual soul, and when through the same power each of us learns to contribute our own virtue to the whole community, then not just a king, but every citizen, will feel, however dimly, *l'etat c'est moi*, I am the state.

Unfortunately, chaos — and not a new social harmony — appears the more immediate prospect. The technologies now overwhelming society stem from a one-sided preoccupation with the perfection of logical subtlety. (I'm sure the medieval doctors would have been struck dumb with amazement at seeing a printout of the silicon logic of an Intel Pentium.) And these same technologies are widely recognized to be killing off the budding imaginations of our children.

I'd like to mention in conclusion that I work for a small research organization in upstate New York called The Nature Institute. We try to cultivate an understanding of nature and society based on imaginative, ecological thinking. That is, we pursue a science that is qualitative, holistic, and contextual.

In our view, what we need today is not globalism as it is currently understood, but holism. We can't, however, produce healthy social wholes until we are capable of *thinking* them. I hope I have suggested to you that the battle for the globe is at the same time a battle for local places and, ultimately, a battle for the quality of your and my thinking.

Thank you.

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