In Context

Number 13 Spring 2005

The Newsletter of **The Nature Institute**

#13

Dear Readers,

In this issue you will find some new authors represented: Siegward Elsas, Vladislav Rozentuller, and Sophia Sherman. This is part of our effort to let the broader work of The Nature Institute find expression in the newsletter.

We were certain from the beginning that *In Context* could not be a journal. The logistical side of maintaining a journal was far beyond our available resources. This continues to be the case, so that we still do not anticipate accepting unsolicited manuscripts in the foreseeable future. The newsletter is essentially an in-house publication, designed to let friends of the Institute know about our on-going work.

But as we reach more effectively into the surrounding society, collaborating and coordinating with others, bringing visitors in for lectures and workshops, and expanding our affiliate staff, we are blessed with a wider range of riches that we can call (more or less) “in-house.” We want you to gain some of the benefit we ourselves enjoy from these connections.

This year we are completing the seventh year since our founding. Much energy during this time has gone into securing a stable existence for the Institute. While we can by no means relax on this front — in some ways, we will face the biggest challenge so far during the next couple of years — we believe that in the future our own fortunes will be linked inseparably to our powers of outreach.

One of our key resources in this regard is *you*. By passing *In Context* on to others, referring people to our website, and giving us the names of people to whom we should send literature, you can help the Institute become a more effective force in the world. And perhaps you know of other people who are doing work we should know about. Nor should you forget yourself! Whatever your connection to The Nature Institute, we are always happy to hear first-hand about the things that excite you and relate to your own undertakings.

We have a new director. Benjamin Bingham has joined the Institute’s Board of Directors. After training in biodynamic agriculture at Emerson College in England, Ben started the farm at Triform, a Camphill community for young adults near Hudson, New York. He is active in several non-profit and for-profit organizations, including the Sustainable Business Network of Philadelphia. Currently he is a wealth management specialist in West Chester, Pennsylvania. He sometimes takes clients and friends to Macchu Picchu, Peru, discovered in 1911 by his grandfather, Hiram Bingham. We are delighted to have Ben’s participation in our endeavors!

Craig Holdrege Steve Talbott

Craig Holdrege *Steve Talbott*

The Nature Institute

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Research Collaborations

Scientific work becomes richer through collaboration — a truth we have had many occasions to recognize during these past several months. Some examples:

In December, molecular biologist **Ann Kleinschmidt** from Allegheny College in Pennsylvania came to the Institute for a week. Ann is looking into ways to bridge the gulf between the products of biochemical analysis and the unmanipulated whole organism. So she's been studying the phenomenology of plant growth in the Mustard family and at the same time doing protein analyses of various tissues at different growth stages. How do these two studies relate to each other? It may seem a simple question, but it's one that has been systematically ignored in biology.

Craig watches as Ann Kleinschmidt transfers mustard plant samples for protein analysis.

How can we bring knowledge of molecular biology back into meaningful connection with the whole organism? During the week, Ann showed Craig how she analyzes plants to determine the expression of a particular family of proteins called peroxidases. This allowed him to experience the world of the molecular biologist and it helped Ann make more explicit the steps a molecular biologist takes and the assumptions she makes along the path of isolation that leads, in the end, to "read-outs" showing black bands of protein. They also discussed the assumptions that are made and all the challenges involved in relating the biochemical pictures back to the whole plant. Ann is continuing this work on her sabbatical.

David Auerbach, a physicist specializing in fluid dynamics, worked together with Craig and Henrike Holdrege on the question of the physical parameters of blood flow. Craig invited David to come after running into a number of stumbling blocks in his attempts to understand the scientific literature about the giraffe's circulatory system. They met daily for a week. David did a wonderful job of leading Henrike and Craig into an understanding of the basic phenomena and laws of fluids and flow from the perspective of physics. Especially for Craig, as a nonmathematical type, it was nice to be led step by step into the material and not get lost.

It quickly became apparent that a physicist has a wholly different take on things from a biologist who looks at form. But it also became clear that if, as a biologist, you don't know something about physical laws that affect life, your understanding will be limited or even skewed. So, for example, we spoke a lot about hydrostatic or gravitational pressure, which increases with the height of a fluid column. The giraffe, as an especially tall and vertically oriented animal (4-5 meters high), has to deal with greater pressures and greater fluctuations in hydrostatic pressure than other mammals do, just by virtue of the fact that it has a fluid-filled body in earth's gravitational field. But how does this affect its life and its circulatory system?

It is by no means easy to answer such a question. One reason is that — and this was another revelation — we noticed how meager are the data within the scientific literature on the giraffe's circulatory system despite the many articles on the theme. But at least we got to the point of being able to ask some pertinent questions and to separate some of the wheat from the chaff in the research. Craig is currently continuing this work.

Mark Gardner has a life-long interest in physics and especially in a Goethean, phenomenological approach. After his participation in a study group on optics at the Institute during the 2003/2004 academic year, he and Henrike Holdrege started studying mechanics together this past fall. They meet weekly at the Institute. They are trying to retrace the pathway that Galileo and his successors followed in uncovering the fundamental laws of mechanics. What were the actual observations of these pioneers? How, and in what ways, was mathematical thought brought to bear on the observations? All too often mathematics is applied in an unreflective way as a tool in physics, without one's observing the thought processes involved and their relation to the appearances. In their work, Mark and Henrike seek to shed light on these relations.

One fruit of Steve's work with **Slava Rozentuller** is the feature article you'll find in this issue of *In Context*. With a background in both biochemistry and drama, Slava has spent a lifetime exploring what you might call the "language of gesture." This requires, on the one hand, attention to the forms of movement implicit in imaginative thinking. How do our thoughts want to express themselves bodily? It emerges from Slava's work that thinking, however much we have learned to ignore its characteristic gestures, always has form and movement. This sculpted form is not something merely added to our thoughts, but is the *expression* of their full content. It is what keeps them from being abstract and dead.

In the other direction, we must attend to the thinking implicit in the body's (and the world's) dynamic forms. We gain *understanding* of these forms only when we raise them up in a disciplined way to imaginative consciousness.

And so, through attention to the conversation in both directions, the human being in his or her *entirety* becomes (in Goethe's terms) an organ of perception for the world. The head lives in intimate dialogue with the limbs, and the limbs with the head — a dialogue mediated by the aesthetic judgment and feelings of the heart. And fluency in this exchange is an essential foundation for the conversation that imaginative thinking can carry on with the body of the world. Without such fluency, we have no living language for understanding the world.

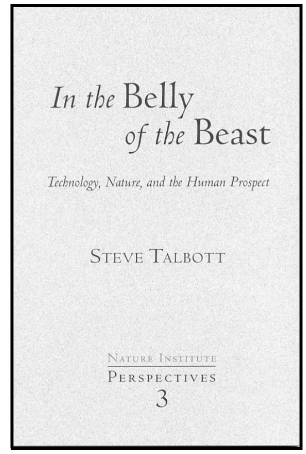
In coming up to the central question of his own work, "How can we have a qualitative science?" Steve has had to confront his own life-long and extreme head-centeredness, which has at times made the problem of qualities seem unapproachable. (See "The Trouble with Qualities" in *In Context* #6.) But his ongoing and intense exercises with Slava over the past several months have, he feels, been bringing life (and movement!) into his work in a way he never imagined possible.

Getting the Word Out

The Nature Institute continues to be productive on the publications front. Here are some highlights:

Nature Institute Perspectives #3. Last December we published the latest entry in our Nature Institute Perspectives series — Steve's *In the Belly of the Beast: Technology, Nature, and the Human Prospect*. The seventy-four page booklet ranges widely over topics such as these:

- How Odysseus employed a kind of technical trickery (in the deepest sense of "technical") upon his journey of self-discovery. We can recognize a worrisome reversal of his journey in our own experience with technology.
- Lessons derived from exploration of the Amazon basin and from the dissolution of the cultures there under the impact of western civilization.
- How to find a third way between conquering or manipulating nature, on the one hand, and preserving nature "untouched," on the other.



- The paradoxical role of abstraction, object-thinking, and detachment in preparing the way for humanity's future development and our stewardship of nature.

This booklet joins the two earlier ones: *Extraordinary Lives: Disability and Destiny in a Technological Age*, and *The Flexible Giant: Seeing the Elephant Whole*. The booklets are $8 plus shipping. Quantity discounts are available. An order form is enclosed in this issue.

Genetic Engineering and Biotechnology. Genetic issues remain one of the main focuses of our work. Proponents of genetic engineering often claim that the technology is essential if we are to solve the problem of world hunger. Craig wrote a full-length essay, "Will Biotech Feed the World? — The Broader Context." We published this on our website and also distributed it to over fifty key organizations and individuals active in the social and political arena. See natureinstitute.org/txt/ch/feed_the_world.htm.

Then Steve wrote an article entitled, "Logic, DNA, and Poetry," in *NetFuture* #160 (netfuture.org/2005/Jan2505_160.html). The piece was picked up by *The New Atlantis* for its spring, 2005 issue. This journal is distributed to every congressional office as well as to some 3000 "opinion leaders" — journalists, government policymakers, think tank scholars, and so on. All this in addition to its regular subscribers and web-based readers.

Also, in *NetFuture* #161 Steve wrote a response to an essay by the *New York Times*' Personal Health columnist, Jane Brody. He took forceful issue with Brody's rather strange (if not outrageous) contention that genetically engineered crops should be considered less risky than conventionally bred crops. You will find Steve's article at netfuture.org/2005/Mar0905_161.html.

Special Publication on Goethe. The interdisciplinary journal *Janus Head* is producing a special issue entitled "Goethe's Delicate Empiricism." It will contain a variety of

Goethean Science Studies

A New Semester-long Course at The Nature Institute

April 2 to June 16, 2006

What would the world look like if we as human beings were able to think like a plant grows? Imagine gaining such flexibility of thought that our ideas were no longer rigid, static and object-like, but grew, transformed, and when needed, died away. And as with plant form, what if our thoughts revealed the living qualities of the world we inhabit? What a revolution! This is the revolution that Goethe began with his approach to doing science. It is a way of wakefully entering into the living forces of the world and learning to think and act in harmony with them. This revolution lies at the core of The Nature Institute's work.

We have long thought how important it would be to have a training course in the Goethean approach to science. Couldn't such training provide a strong infusion of living thought into our culture? We have seen how participants in our week-long summer courses can discover new ways of thinking and observing while also experiencing the powerful effect of working together. What could we achieve over a longer period of time, with students plunging more deeply into content areas and — in interaction with others — experiencing the struggles and rewards of new, unexpected vantage points? So, after much consideration and many conversations, we conceived an eleven-week course that we believe will provide an intensive, practice-based training. It will be carried by Institute staff and a number of guest teachers.

We have chosen to hold the course in spring so that we can best work out of the genius of place and time. The rapidly and richly unfolding plant life in spring in the Northeast will be a natural focus for our work. The Nature Institute is located in a biodynamically farmed valley with forests, meadows, wetlands, creeks, ponds and many transitional habitats within walking distance.

The key to learning the Goethean approach is practice: gaining more awareness of how we think and how our thoughts are interwoven with the world; learning to observe quietly and closely; and developing an active, participatory imagination. You could say that the goal of this work is to transform our faculties so that the world can better reveal itself through us.

There will be two core seminars on the practice and methodology of the Goethean approach, both emphasizing hands-on observation and self-awareness in thought. These courses will be accompanied by readings in Goethean science as well as field trips. The seminar on "The Visual World: The Phenomena of Light and Color" provides a wonderful introduction to phenomenological science. The main core seminar on "The Life of the Plant: Morphology, Metamorphosis and Ecology" lays the groundwork for a dynamic and holistic understanding of life.

As an aid to flexible thinking, students will have an ongoing course in projective geometry. In addition, drawing and/or painting classes will help students develop a habit of careful and sensitive observation.

An important element of the course is the individual project. Each student will choose an area of study (for example, a plant species, a species comparison, a habitat study, and so on) in which he or she independently applies the Goethean approach. This project will extend over the length of the course and each student will give a project presentation.

Finally, to give students an impression of the depth and breadth of the Goethean approach, guest teachers will give talks and seminars out of their areas of expertise.

This course is for people from all walks of life who are interested in a deeper understanding of nature based on transforming human capacities. Whether you are looking for ways to incorporate organic principles into your profession, are on a sabbatical or in job transition and need a fresh take on things, or are a college student yearning for experience-based learning, this course might be what you are looking for. We will carry out the course if we have seven or more students; the maximum number of participants is fifteen. We presently envision offering the course every other year. College students should inquire about the possibility of receiving college credits for the course. (Students in our guided study program have received college credits.)

We are excited about this new offering. You can find more information on our website and we will be sending out a course brochure. If you know of people who might like to receive a brochure, please let us know. Help us spread the word about this unique educational opportunity.

articles on Goethe's approach to science. Some of these articles view Goethe's work from the perspective of other thinkers such as Wittgenstein, Thoreau, and Emerson. Others describe the unique features of Goethe's approach to knowledge and science. A number of the authors are Nature Institute friends — Bill Bywater, Allan Kaplan, Christina Root, and David Seamon have all participated in courses here. Craig is co-editing the special issue along with Bill Bywater, and he has also written an article for the issue entitled "Doing Goethean Science."

The special issue will be available online in August and soon thereafter in hardcopy. To access the journal, go to www.janushead.org.

Science and the Child. The *Research Bulletin* of the Research Institute for Waldorf Education (January, 2005) published Steve's article, "Science and the Child." Previous versions of this piece appeared in *The New Atlantis* (spring, 2005 issue) and *In Context* #12 (fall, 2004). This is the kind of multiple exposure we like to achieve in our work! The full text is available at qual.natureinstitute.org.

Qualitative Science. Finally, after completing (for the time being) his series of critiques of mechanistic science, Steve has launched upon the more positive half of this work by publishing in *NetFuture* the introductory essay in a series entitled, "Toward a New, Qualitative Science." This particular article, "Recognizing Reality," looks at opposite poles of human cognition: the inner movement whereby we try to analyze, divide, isolate, decontextualize, and precisely define reality, and the contrary movement whereby we seek to do justice to the integral and expressive content of reality. The emphasis is upon the latter. The essay concludes this way:

> All, or nearly all, of us have no difficulty reading the smiles of our spouses, children, and friends as much more than "widenings of the oral aperture, caused by contractions of the cheek musculature." Some among us develop great skill at understanding the entire range of human expression, learning to commune deeply and sympathetically with the self doing the expressing. This sort of understanding — as every one of us (scientist or otherwise) assumes in daily life — is real and objective, even if it is very unlike our knowledge of machines. It leads to possibilities of conversation and exchange that are as deep as our understanding.
>
> If you deny this knowledge; or if you would split the world's truth down the middle, refusing to accredit half of it as scientific truth; or if you equate science with technology and our powers of mechanical manipulation — then you will have no reason to read further essays in this series. But if you are at least open to the possibility that the face of the larger world — a face every bit as qualitative and expressive in its own way as the human face — might be read meaningfully and with objective understanding, then I invite you to proceed along with me in this forthcoming exploration.

The essay, "Recognizing Reality," is available at qual.natureinstitute.org.

A New Affiliate Researcher

We are very happy to announce that Dr. Siegward-M. Elsas has been appointed an Affiliate Researcher at The Nature Institute. You may recall a note in the last issue of *In Context* describing a seminar we held with Siegward concerning the relation between nerve activity and consciousness. In this current issue you will find an article by him on the same topic.

Siegward Elsas, M.D. is a physician and Assistant Professor of Neurology at Oregon Health and Sciences University in Portland. His medical training was at the University Witten/Herdecke in Germany. Siegward Elsas is pursuing a phenomenological approach to neuroscience, with a particular interest in electrophysiology and the sensory organization. In this context, he is currently developing a new approach to diagnosis and treatment of epilepsy.

Siegward describes his interests this way:

> My interest in phenomenological natural science began in medical school in Herdecke, where my hopes for a holistic approach to anatomy and physiology were not met. I became familiar with Goethe's writings on the metamorphosis of plants and animals, and then initiated a student study group on phenomenological science, which met for about five years during my time as a student. This group was inspired by activities of the Carus Institute in Öschelbronn (near Pforzheim/Germany). We studied, organ by organ, embryology and comparative anatomy and physiology. My interest in the complexities of the nervous system then led to 4 - 5 years of postdoctoral research in the basic neurosciences and eventually to becoming a clinical neurologist. My interest to take this impulse back to the academic world then brought me to my current position at Oregon Health and Sciences University. A recent award of a federal NIH research grant allows me to pursue research in holistic treatments of epilepsy, including related mind-body questions.

We look forward to continuing collaboration with Siegward, and welcome him to the Institute.

Nature Institute Events

We have hosted many events during the past six months. Here's a glimpse into the busy schedule:

Talks Bridging Art and Science

We have had a number of talks and workshops that revolved around the relation between art and science. We want to do as much as we can to break down the barriers that separate traditional disciplines. Only a multi-sided view of things can give us true depth of understanding. These talks included the following:

A Painter's Search for Meaning in Nature. A talk and exhibit of new paintings by Thomas Locker, an artist and children's book writer and illustrator. Locker unveiled a series of new paintings of the Kaaterskill Clove in the Catskill Mountains. He spoke out of his appreciation of the Hudson River School, and particularly the work of Thomas Cole, whose paintings of the same landscapes have inspired Locker since childhood. Using the Native American metaphor of the "seven directions," Locker described his striving to bring something of nature's essence to expression in his art. The talk was followed by a panel discussion on finding meaning in nature through art, science, and religion. The event was a fundraiser for The Nature Institute (March 12).

Thinking Through Metaphor: Figurative Language as a Key to Understanding Goethe's Phenomenological Approach to Nature. A talk by Christina Root (October 29).

How Do Animals See the World? — In the Footsteps of Painter Franz Marc. An evening talk and Saturday morning workshop with Jan Kees Saltet and Craig Holdrege (September 24 - 25).

The Nature of Drama and the Drama of Nature. A talk by Slava Rozentuller. See the feature article, "From Two Cultures to One," in this issue (September 10).

Talks on Science and Technology

Grasping for Certainty, Fleeing from Meaning: The Dilemma of Science and Some Thoughts on Its Resolution. A talk by Steve Talbott (April 14). For articles related to this talk, see qual.natureinstitute.org.

Science at the Crossroads: A Battle Between Life and Death. A talk by David Auerbach (January 27).

The Trouble with Genetic Engineering: New Developments in Biotech Food and Agriculture. A talk by Craig Holdrege (November 11).

Workshops

Wildflowers of the Spring Forest. Spring wildflower walk with Craig Holdrege (May 21).

Here Come the Birds. An early morning birdwatching walk with Harry Lazare (April 23).

Introduction to Winter Wildlife Tracking with Michael Pewtherer and Jonathan Talbott (January 22 and February 12).

Ongoing Courses

Henrike Holdrege conducted two projective geometry courses in the fall. The spring course, *Projective Geometry: Extending Our Boundaries and Experience of Thought,* began March 29 and continues for ten classes on Tuesday mornings.

Out and About

A Living Concept of Heredity and Genetic Engineering. Half-day workshop at the Biodynamic Gardening training, Pfeiffer Center, Spring Valley, New York (March 19).

Projective Geometry. Course taught by Henrike at the Garden City Waldorf School High School teacher training program (January 15-17).

Science from the "Inside." A talk by Steve Talbott to the New York City Anthroposophical Society (December 10).

Encountering Nature as a Conversation: Our Responsibility as Human Beings for the Earth. Public talk and workshop with Craig Holdrege. Austin Waldorf School, Austin, Texas (November 5-6).

From Wonderbread to GM Lettuce: Genetic Engineering and Our Food. Public talk by Craig Holdrege at the Austin Waldorf School, Austin, Texas (November 4).

Understanding the Wholeness and Integrity of Nature. Section taught by Craig Holdrege as part of a three-week public course at Schumacher College (Dartington, England). The overall course was entitled "Holistic Science: Seeing with New Eyes." Craig also taught in the Masters Degree in Holistic Science program (October 13-21).

2005 Summer Courses

Our week-long summer courses provide the opportunity to "get your feet wet" in the Goethean approach to studying nature — and, for those of you already familiar with the approach, to practice it further. While the teachers are guides, in every course in the past years we have vividly experienced what Goethe says about doing science: "Only the interest of several people focused on a single point can bring forth something truly outstanding." So join us in our cooperative effort to deepen and enliven our understanding of nature and ourselves.

Places are still available in both the following courses, as is financial assistance. To register for the courses, please contact us by mail (20 May Hill Rd., Ghent, New York 12075), phone (518-672-0116), or email (info@natureinstitute.org). You can find more information about the courses on our website: natureinstitute.org. *Please register by June 1.*

June 26 – July 2

Advanced course: *Practicing a Goethean Approach to Science.*

This course is for people who are committed to the ongoing practice of Goethean science.

July 10 – July 16

Coming Alive to Nature: Reading the Gestures of Life

A week-long interdisciplinary course for people from all walks of life.

A New Library and Kitchen

Since we moved into our building in March, 2002, the Institute has steadily increased its educational offerings, bringing more people into our building. In 2004 we held twenty-one different events at the Institute that attracted over 500 people. As most of you know who have been here, the Institute's building is a former residence. Two years ago we remodeled part of the basement into a teaching space. We use the living/dining area as our lecture and main course room. The bedrooms have become our offices. Our library spreads out over several rooms. The Institute is a beautiful place to work and have courses, but the time has come for further improvements.

To increase the effectiveness of our services to visitors and course participants, we are remodeling two spaces in our building: we will create a proper library and an events kitchen. We have an unfinished room in the basement that we are transforming into the kitchen. The present kitchen will be dismantled and made into a library that can house our books (presently about 1,000 volumes) and also be a space for quiet study. This renovation will make it much more convenient and pleasant for community members and participants in Institute courses and events to use our library. An events kitchen in the basement, with its own separate, easily accessible entrance, will allow food preparation to function more smoothly without disrupting the ongoing activities on the main floor.

The total cost of this renovation is $11,800. We have received $2,000 from the Berkshire-Taconic Community Foundation for this project and have funding proposals pending with other local and regional foundations. In order not to use our reserves, we still need $6,000 in individual donations to help fund this project. If you would like to make a contribution to it, please make a note on the donation envelope. Our goal is to have the work completed by the end of June.

* * * * * *

Any institute needs a good library — the internet cannot substitute for a collection of good books. At the present we have about 1,000 volumes: Goethean science, natural history, nature writing, history and philosophy of science, all areas of biology, field guides, and a growing collection of books in the other sciences as well. We also received many excellent philosophy and science books from the library of the late Ron Brady. We are now making a concerted effort to catalog all of our books so that the collection can be put to better use. When the remodeling project is done, we will have a great little research library.

Like all good things, this project has its costs: bookcases, cataloging supplies, a cataloging program (that helps us print out all the cards — we will have an old-fashioned card catalog), and substantial personnel time to do all the data entry. We'll need about $3,500 to carry out this work.

How's The Nature Institute Doing?

When people ask me this question my thoughts go in two directions. On the one hand, I think of all the work we're doing and can only reply, "Great!" — and add that we wish we could accomplish more, since there are so many important things to do.

On the other hand, I think of finances. Here again my thoughts take a double trajectory. Positively, I think of the fact that in six years our financial numbers have been "in the black." Our budget has grown from year to year, reaching $227,000 in 2004, and our funding base has expanded to allow this growth. Our funding comes through foundations, individual donations, and earned income. In 2004, we received grants from 16 different foundations (ranging in amount from $1,000 to $48,000), we received 400 individual donations (from Friends and subscribers to NetFuture) totaling $46,000, and took in $20,000 through our courses and events. We have a circle of volunteers who selflessly help out where help is needed. This all points to a broad field of connections that anchor our work in the world and make that work possible. For all this we are deeply grateful — and amazed that things have developed so well.

But — and this is the other trajectory — I can never talk about our financial situation with a sense of ease. Each year begins with the question: will we find the funding necessary to make it through the year? That situation has not changed. Our 2005 organizational budget is $254,000 and we need, in addition, $11,800 for our remodeling project (see separate article in this issue). We still need to raise $110,000 to cover these expenses.

Some smaller foundation grants are pending, which could together amount to $20,000, and we hope to bring in $20,000 through our education programs. So this leaves us with $70,000 to raise. This is the largest amount we've had to raise in a short period of time (as I write: within nine months).

There are a number of ways that you can help:

Do you have any contacts at foundations? We need to make connections with new foundations, which is no easy task. As we have already experienced, it makes little sense to send out proposals to myriad foundations in hope of getting a positive reply — you almost inevitably receive a friendly denial via a form letter. Foundations are swamped with requests, so having a personal contact is key to even being noticed. If you know people in foundations who might be interested in our work, please let us know.

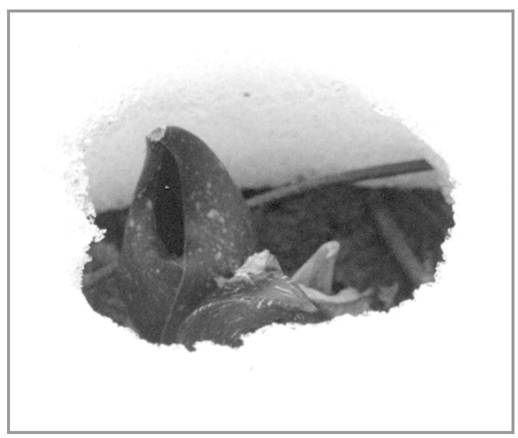
Can you make a donation yourself? Clearly, the Institute needs increased support from our friends and readers. Presently 1,800 people receive *In Context* and as you know, there are no subscription fees. We want as many people as possible to partake in the fruits of our work. Of course, we hope many of you will be moved to support our efforts. So we ask you to consider becoming a supporting Friend or to continue your support as a Friend. Please help this circle grow! Every individual donation counts. I know you receive, like I do, many requests for help. Only you know whether The Nature Institute belongs to the worthwhile endeavors you want to support — I hope it does.

Can you help us reach more people and make our work better known? One way you might do this is to let us know if you have friends who might be interested in receiving *In Context* (or our other publications) and we will send you complimentary issues to pass on. We can also send you brochures that you could put out, for example, at a local store.

The need to *re-think, re-imagine,* and *re-create* our relation to nature is so burning, so urgent, that we will continue doing all we can to make The Nature Institute a vibrant center for this transformation.

But it takes many to accomplish this task. So, if you can, help us to think and act boldly — to do the work that needs to be done.

Craig Holdrege



What's going an here? The white background in the picture is snow. You are looking into a little (about 8 inches in diameter) cavern in the snow created by a skunk cabbage. This year we had plenty of snow in early March and the skunk cabbage spathes, which contain the flower head, grew up under the snow cover. You can see one in the left side of the cavern. It warmed up as it grew out of the ground and melted the snow around itself, creating its own little cave. When we put our fingers in the spathe opening and touched the concealed flower head, it was warm and left pollen on our fingers. Nothing like a flower in full bloom beneath the snow! Yes, skunk cabbage is a strange plant. (Photo: C. Holdrege)

Thank You!

We are grateful to all of you who have contributed money, services, or goods to The Nature Institute (or to its publication, *NetFuture*) between October, 2004, and the end of March, 2005. Please see our financial update on the preceding page.

J. Richard Ackerman
Natalie Reed Adams
Reinout Amons
David Anderson
Nancy Kay Anderson
Anonymous
Elizabeth & Arthur Auer
Tito Autrey
Gary Banks & Rise Smythe-Freed
Henry Barnes
John Barnes
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Ursula & Klaus-Georg Becher
Terrell & Jean Beck
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MEMORIAL

In memory of Betty Lou Holdrege

Barbara Holdrege & Eric Dahl
Holdrege & Kull, engineers
John Jake Hudson

Waitomo: New Zealand's Glow-worm Caves

Sophia Sherman

Sophia Sherman, a local friend of The Nature Institute, shared with us the following notes from her travels. We thought they would interest many readers of In Context.

In December 2004 I took a trip to New Zealand, with six weeks to explore the country's natural wonders and volunteer on organic farms. New Zealand consists of two large islands with beaches, bays, and fjords, and many smaller islands along their coasts. Near the center of the North Island is a region called Waitomo, where steeply rolling green hillsides, cleared long ago of native bush, provide pasture for thousands of cows and sheep.

At 40 degrees latitude — nearly identical but inverse to my home in Harlemville, New York — the temperate climate of this South Pacific countryside supports the same European grasses and flowers that are naturalized in the northeastern U.S. December in Waitomo smelled deliciously and uncannily like June in Harlemville. Others have described it as a replica of English farmland. Clovers, plantains, dandelions, and grasses bloom alongside wild foxglove and lupines. Lush native ferns, mosses, and liverworts flourish in small stands of trees and pockets of bush.

Landscape where glow-worm caves occur in the Waitomo region of New Zealand. (Photo: Sophia Sherman)

Despite the familiarity, something about the landscape pulled vaguely at my attention. The hills were not rounded with glacial history, nor were the valleys wide flood plains or steep, river-cut waterways. The land appeared folded, almost like a thick cloth spread flat then scrunched up into clumps and ridges. Glow-worms had drawn me to the area, and their remarkable flourishing in that particular region turned out to be directly related to the curious landscape.

Waitomo is an indigenous Maori name meaning *water hole* or *water shaft*. The bedrock in the region is limestone, run through by over three-hundred known caves of various shapes and sizes, a number of which are several miles long. Streams flow through many of these natural tunnels, and it is in this dark, damp world that glow-worms thrive. When portions of the caves collapse, deep shafts open, through which humans and other life forms gain access to a realm of marvelous rock formations and the intriguing, luminous larvae. A wide range of viewing and adventuring options are available to interested visitors, from gentle guided walks to rock climbing and blackwater rafting or tubing. I chose a trip called Rap, Rock and Raft.

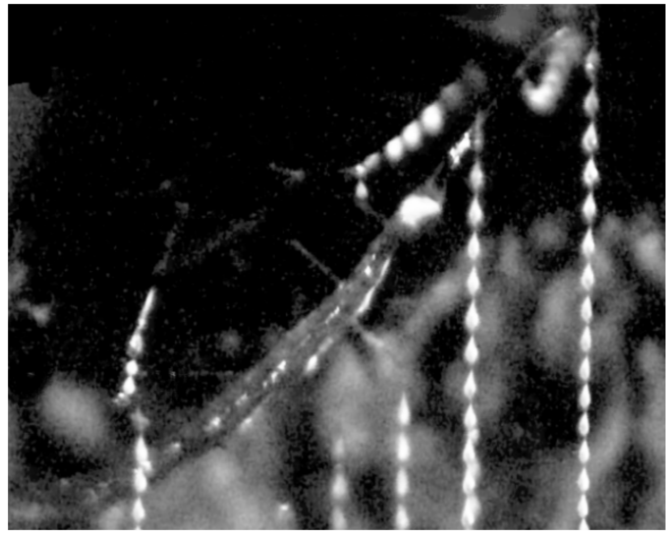
Along with an Australian teenager and her father, I squeaked and tugged my way into the necessary, damp gear—full wet suit, climbing harness, rubber boots, and a helmet with attached head lamp and waist-belt battery pack. We bounced off in a damp jeep, following a long, winding track of white gravel through sunny pastures. At last we stopped in the middle of a field, just above a stand of poplars nestled into one of the folds of land. White sheep munched and looked on calmly as we stepped awkwardly out onto the grass. Making our way down into the trees, I realized what gave the landscape—at least in part—its unique contour. The hills hadn't been thrust upwards or simply eroded; in many places, the earth between them had fallen in.

I had to walk deep into the steep, green crease before I had any idea where the cave entrance was. At the end of a tiny wooden walkway, I could suddenly see eighty feet into the earth through a great crack about twelve feet wide. Following our guide's instructions, I clipped into the abseil rope and began lowering myself down towards the stream running over the dark rocks below. At first the walls of the chasm were lit by the sun, with clumps of grasses and flowers growing on little ledges. As I descended, I passed ferns, mosses, lichens, and liverworts, until eventually even those gave way to bare, clammy rock and flowing water. At the bottom I scrambled along the slippery, uneven ground to a place where I could look up through a wider opening at a narrow strip of sky and distant fringe of green. Another set of ropes hung there, ready for our climb out. The stream flowed swiftly out of a dark tunnel on my right, through the broad, open cavern where I stood, and back into a tunnel of rushing, echoing blackness to my left.

Once the whole group had reached the bottom, our guide unlashed an inner tube for each of us from the rope anchored to the cave wall, showed us how to turn our headlamps on and off, and started walking rapidly upstream. Cold water gushed into my rubber boots and seeped into my wetsuit as I stepped into the current. At first it was all we could do to carry our tubes and keep our footing on the uneven streambed, but we gradually settled into a reasonably steady pace and our eyes began adjusting to the darkness. Although the dimensions varied, the cave was usually about twelve feet high and wide, with frequent turns that soon blocked all daylight. The water quickly went from mid-thigh to waist-deep. We had to concentrate so hard on walking for the first fifteen minutes or so that none of us even looked for glow-worms.

Suddenly our guide stopped and told us to pull our tubes up onto a sandy bank, make ourselves comfortable, and turn off our headlamps. We lounged back and looked around, immediately awestruck. We had entered a wide cavern, and the ceiling shone like the brightest night sky imaginable. Innumerable small points of pale green light glowed steadily on the vast expanse of ceiling. As our eyes adjusted to the new darkness, the lights seemed to grow even brighter. The water, winding away through the blackness, gleamed along all its visible length, as if luminous with starlight. The air was fresh and cool; the cave felt serene and spacious. We settled comfortably into the sand as our guide began to tell us about glow-worms.

The glow-worms in Waitomo are actually not worms at all, but the larval form of the fungus gnat, *Arachnocampa Luminosa*. During their approximately nine-month larval stage, they grow from less than 2 mm. to an inch or more in length. They then pupate for about two weeks in cocoons suspended from the cave ceiling. The adult insects, which look similar to large mosquitoes, have only the most rudimentary gastrointestinal tracts and cannot eat. They live for only two or three days — just enough time to mate and lay a cluster of eggs on the walls or ceiling of the cave. When the larvae hatch after about three weeks, they immediately begin glowing and migrating toward available ceiling space above the water.



A glow-worm lies in wait for its prey. Its body extends from the lower left toward the upper right, with the glow at its upper end. What look like strings of beads are the sticky filaments for trapping insects. (Photo courtesy of the Springbrook Glow Worms Research Centre)

Male and female flies mating adjacent to a pupal casing (upper right) from which the female (top center) has emerged. The two flies form an approximate 'V'. (Photo courtesy of the Springbrook Glow Worms Research Centre)

The larvae can live in any place that is moist, dark at least some of the time, and where there is an overhang from which to suspend their hammock webs or "nests." They trail long sticky filaments of "fishing line" into the air below them, as many as seventy strands per larva, snagging and reeling in the insects that fly toward the green lights.

(Continued on page 18)

From Two Cultures to One

On the Relation between Science and Art

Vladislav Rozentuller and Steve Talbott

This article is in part adapted from a talk given by Vladislav Rozentuller at The Nature Institute on September 10, 2004. The talk was entitled, "The Nature of Drama and the Drama of Nature."

All science is rooted in experience. We have nowhere to begin except with whatever we are aware of — and nowhere else to end either. If, as scientists, we discipline and extend the range of our experience, we do so in order to gain new understandings describable in terms of this widened experiential horizon. How could we understand or describe anything that lies entirely outside our experience?

The link to experience can be easy to forget amid what physicist Arthur Zajonc has called the "mess of formulas" constituting the hard sciences — and all the more so when our philosophical heritage inclines us to believe that objective truth consists precisely of whatever is not contaminated by human subjectivity. Since our experience is always the experience of a human subject, this distrust of the subject puts the experiential basis of science at continual risk.

We can sense the risk when we note how experiment in science has more and more become the province of computer simulation and of elaborate equipment that disconnects the researcher from the crucial events being investigated. At the same time, we see how the fascination with rigorous mathematical deduction and with the neat, step-by-step, logical determinism of algorithms threatens to carry us away from an observation-based science and back to a kind of medieval attempt to seize the world's truth through the necessities of pure, abstract cerebration.[1]

Subjectivity and Objectivity

But a science removed from experience is no longer science. It becomes something different, and is likely to degenerate into the dogma of mere belief. The philosopher Kurt Riezler was targeting this confusion over the experiential basis of science when, at mid-twentieth century, he admonished physicists this way:

> [M]ost of your notions change color in a twilight. You use the word "force" and, when queried, you define it by law, field, and vector; but what you really have in mind is the force you feel in commanding your muscles. Do not imagine, however, that you are uniting these two: you mix up unconnected notions, surreptitiously exchanging one for the other. All your thinking goes on in such ambiguity. (Riezler 1940, p. 11-12)

There is no quarreling with the fact that the fundamental concepts of science — those that might tell us what sort of reality our wonderfully precise equations are *about* — remain strangely unapproachable and mysterious. Physicist Richard Feynman felt compelled to admit that "in physics today, we have no knowledge of what energy *is*" (1963, p. 4-1). Other theorists can be heard asking whether time can flow backward, and whether we all exist in multiple, parallel universes. And who can tell us with great confidence about such basic aspects of our world as the nature of space or the character of matter?

Such mystery is hardly surprising when you consider how remote from human experience physics has become today. Things might be different if we were to explore the roots of science within ourselves. Can we gain an adequate scientific understanding of gravity except by referring to the willful use of our muscles? A little reflection will convince us that the answer is no. True, many scientists will react initially to the question by citing the purely objective relationships of moving masses — relationships given in strictly mathematical terms. But the word *relationship* here turns out to be more than "just a little" pregnant. It conceals — so long as we are willing to avert our gaze — what *sort* of connection between things we really have in mind.

Objects changing their positions in space may give us a certain mathematically describable lawfulness, but so, too, can points on a piece of graph paper. No one takes those points to be exerting a physical force upon each other. Neither could we think of planets as exerting a force upon each other *unless we had an independent concept of force.* As the graph paper illustrates, the mathematical relationships alone do not give us knowledge of a force. Think about it all you wish, but you will never find a source for this concept except in the inner experience of your own body.

This truth may be obvious to those who are willing to consider the matter. But if our experience gives us an essential part of our science of gravity — if it gives us the actual physical *meaning* of our equations, telling us what they are about — then the implications for science are radical. In particular, we come to see that science has validity as an attempt to understand physical reality only because our experience provides a language of revelation for this reality.

Actually, the question how our world of inner experience relates to the outer or objective world is raised even by the mathematics that is so central to our scientific formulations. Is this mathematics "in our heads" or in the world? Eminent scientists and mathematicians have lined up on one side of the question or the other. But the obvious fact of the matter is that both contentions are true. What prevents acceptance of this is the reigning Cartesian dualism: if mathematics is conceptual in nature and therefore part of our mentality, as it so clearly is, how can it also be out there in the world? Yet all scientists assume that, in characterizing the mathematics of gravity, they are telling us something objective about how the world really is. Somehow the thoughts we so easily assume to be in our heads also belong to the world.

Once we reckon with Riezler's point about muscles and forces, we realize that the objective-subjective question goes far beyond mental formalisms such as mathematics and logic. It is our entire realm of inner experience that seems to refer to the world outside — or is it that the world outside refers to our inner experience? This reciprocal relationship will be far easier to grasp once we have overcome the Cartesian cleavage — as nearly all thinkers today *say* they want to do.

But it can be desperately painful to let go of centuries-old habits of thought. When we do manage to transcend the great Cartesian divide, we will recognize how natural it is that our interior should give us the key to understanding the outer world. Consciousness is not something that merely goes on inside our own skulls; it is the inner aspect of the world. Just as our mathematical concepts belong not only to us, but to the world as well, so also more generally: our own interior is at the same time the world's interior. We are, after all, part of the world, not aliens from elsewhere. Is it really a surprise that where, in us, the world wakes up to self-consciousness, this consciousness should find itself participating in, and capable of knowing, the world? Only a long history of artificially isolating the subject as knower from the world known could have made us think otherwise.

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The Work of the Artist

We discover the world through experience — *all* experience, and not just the abstract and formal (that is, logical and quantitative) thoughts we like to picture as taking place in our heads. This means that we participate in the world's being through all our senses, experiencing its various qualities with our entire selves. When we consciously live in these qualities (not something we moderns are readily inclined to do), we lay the foundation for understanding. And so imagination and feeling, movement and will, all play a role in scientific discovery. The attempt to ignore this truth is what leads to the confusion in scientific terminology that Riezler noted. The problem is that, despite unavoidably relying upon the qualities of human experience in order to give meaning to their concepts, scientists are discouraged from paying attention to how they do so — or even the fact that they do so.

This ambiguity of attitude is perhaps understandable when you consider the startling cost of removing it and facing an experience-based science squarely. One person who tried to do this was Goethe, and his conclusion would hardly appeal to many scientists today. "Art," he said, "is nature's worthiest interpreter."

Goethe found a close kinship between the creative processes in nature and our own artistic activities. As Tolkien would later put it, "we create by the law in which we're made." The highest art therefore has the truth and power of nature — which is why it can be a revelation of nature. The same imaginative power that grows a flower on the ground of the earth also grows the poem in the soul of the great poet.

It is hardly strange to say that the forces at work in nature are also at work in us. How could it be otherwise? But in us these forces gain a voice; they become a language. Goethe believed that nature pursues its own work further through the human soul in order to reach a higher level of perfection.

When Goethe says that art is nature's worthiest interpreter, he has in mind not only the way we feel and enjoy nature through poetry, painting, and the rest, but also how we *understand* nature with the help of art. In fashioning a true work of art, we feel nature's creative and objective laws speaking through us. We learn to work with those laws, and thereby come to understand them. The outer form of an artistic creation, insofar as it is successful, bears an inner meaning true to nature. It captures something of nature's way of being.

The use of outer form to convey inner content, or meaning, is characteristic of all artistic technique, as we can see very well with drama. The dramatic production employs elements of the other arts — words, sounds, music, colors, physical form, and movement — and these elements always point inward. The actor's task is to make his outer actions — movement, pause, gesture, vocal intonation — a revelation of his inner world. The inner reality may be that he is looking for something, protecting somebody, proving something, asking or sacrificing or doubting or despairing. In all these cases the inner attitude and inner movement can be suggested through the qualities suffusing his bodily movement and speech. The body becomes a language of soul.

Not only the actors but even the elements of staging enter into the conversation between outer appearance and inner meaning. A detail such as a dry leaf may suggest a certain dying process in the soul. A blue sky may have to do with hope. And if a character is dressed in black, it may convey pain or existential anguish. Of course, such associations may become conventional and trivial. But that is because of lazy habit and dullness of perception. (When was the last time you let yourself deeply imbibe a blue sky?) The metaphors nevertheless originate in a true perception of the qualities of things. In staging a drama, the aim is to bring perception alive again, so that every detail of appearance begins to speak out of one or another aspect of its inner nature.

But actors also use images of nature in a more immediate way. For example, a director may tell an actor, "Enter the room like a snake." Without literally reproducing a snake's movement, the actor takes its qualities into his behavior and mien. He may thereby project a cunningly evasive indirection, or an unblinking, penetrating focus, or the lurking danger of a sudden, venomous thrust — all depending on which qualities of the snake he finds relevant to the inner transactions on the stage.

It would, of course, be an egregious mistake to read human cunning into the snake. But the objective movements of a snake express certain qualities of a cunning person in a way that other movements do not. To anyone who actually works with the language of form, this is just an obvious fact. Every outer form has its own inner qualities. This truth, however is one whose revelatory and scientific significance we have long trained ourselves to overlook.

Likewise, the director may instruct an actor to enter the room like a cold wind — or a blustery wind, or a sodden, rain-soaked wind, or a summer breeze. Each conveys its own distinctive character. Whether superficially or profoundly, we draw on images of nature to suggest inner character all the time: "This man is a wolf." "She has a heart of stone." "His brain is made of oak." "Her smile is like the sunshine." "She is beautiful, but her eyes are like a whirlpool." Just as there are attractive, dark-green, whirlpool-like eyes suggesting a danger within, so, too, all the other metaphors suggest a link between the phenomena of nature and the inner states of human beings. We find in nature powers that work also within us.

As actors know so well, every posture and every movement carries its own inner significance, contributing to a language of form, or gesture, in which outer appearance and inner meaning converse intimately with each other. Stand with your head inclined slightly downward, and you will add a meaning to the scene that differs drastically from inclining your head upward. To move your hand toward an object in a certain hesitating and faltering way is (for the actor whose

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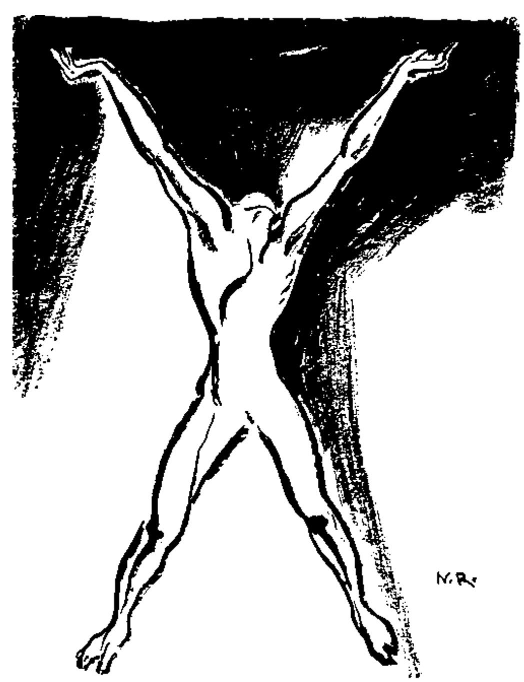

powers of perception and attention have been trained) to experience in the quality of the movement a feeling of distracted worry or anxiety. The feeling is objective in the sense that it belongs to the physical movement itself; the actor need not recall or imagine any purely personal anxiety. But, at the same time, the feeling does become *his* feeling. We could say that the experience has a subjective-objective character: the actor makes of his personal consciousness a stage onto which he invites this or that feeling from the objective world.

The Language of Gesture

This dialogue between inner and outer is no mere peculiarity of the arts. We find the same dialogue in all human language. Owen Barfield, a philologist, reminds us that "language appears at first sight to consist of what has been well called 'a tissue of faded metaphors.'" Thus, to *express* means to "squeeze out," and when we *focus* our minds we invoke the gathering and centering of light by a magnifying glass — and the Latin word *focus* applied to such a glass originally referred to a hearth and the fire burning there. In this way our immaterial meanings arise from the content of world processes.

The inner-outer dialogue implicit in many words is still obvious to us, as with *conceive*, *apprehend*, and *understand*. But it is no less present as a historical fact even where it has long been forgotten. For example, *right* is thought to derive from a word meaning "stretched" and therefore "straight," while *wrong* descends from "wringing" or "sour" (Barfield 1981, p. 35). And, Barfield adds, not even such respectable scientific terms as *cause*, *reference*, *organism*, and *stimulus* are exempt from the general rule. Our innermost, and also our most abstract, meanings arose by grace of external appearances.

Moreover (as Barfield also shows) the same holds true in reverse: our most external and material meanings once bore inner significance as well. In fact, *material* itself is related to the Latin *mater*, which means "mother," with connotations of motherly love and nurture. In general, both our most material and our most immaterial meanings are late arrivals in human history. They emerge through subtraction from the material-immaterial unity our ancestors so naturally experienced (Barfield 1973, p. 134).

An analysis of human language and the role of figurative speech in our meanings, scientific and otherwise, leads Barfield to conclude that if our language has any meaning at all, then objective nature has an inside that is somehow akin to our own interior (1977, p. 15). The claim of objectivity for this interior may be difficult for many modern scientists to

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stomach, but, as we have seen, the problem already presents itself in the case of our mathematical thought. And it becomes even more acute when we look at the work of whole-organism biologists. For example, Craig Holdrege, after sketching the physiology, morphology, and behavior of the three-toed sloth, writes: "Every detail speaks 'sloth'" (1997). If every physical detail of an organism speaks with one voice, it can only be because inner, unifying qualities express themselves through these details. No external structure or individual detail of behavior can provide the unity evident throughout all the parts of a discernible whole.

If not only the organism but also nearly every word of our language testifies to the world's expressive qualities, and if the artist has become conscious and discerning of the gestural language of nature at work in these qualities, then this knowledge is essential to the scientist. The scientist and artist are engaged in the same larger enterprise. Where the artist tries to transform matter in the image of truth, creating outer forms that reveal an inner meaning and significance as clearly as possible, the scientist contemplates the given forms of nature and seeks to discover their inner and lawful coherence. The emphasis for the artist is on creation, and for the scientist on discovery. But the two activities relate to the same reality; the language is one language.

We can call it wisdom when understanding and creative power, knowledge and art, are joined in a higher unity.

The Unity of Art and Science

In his commentary upon Goethe's worldview, Rudolf Steiner remarks that the scientist looks upon the world in order to apprehend natural laws in the form of thoughts or ideas. The artist, by contrast, experiences the lawfulness of a natural process in a more pictorial, and therefore a more deeply felt, way; the creative aim is for a purer, more complete picture of the lawfulness than the world itself normally makes available. Everything contingent, everything incidental to the revelation gripping the artist, is stripped away from the sculpture or painting or dramatic presentation in order to lay bare a particular expressive aspect of the world (Steiner 2000, p. 210; Brady 2002).

Putting it a little differently: where the scientist tries to apprehend the idea of a natural phenomenon, the artist tries to encounter the soul of nature herself. Where the scientist pursues a method of *research*, systematically demonstrating an idea, the artist strives to create an image that is a *revelation* of nature. Faced with the beauty of a sunset, the scientist wants to understand it as deeply as possible, and the artist wants to feel it as deeply as possible.

The two approaches are closely related. The deep feeling sought by the artist is a true feeling, a cognitive feeling — a feeling that can be raised to a conscious, imaginative level where it reveals the inner character of the phenomenon. In the other direction, the scientist's ideas — when they become more full-fleshed than our usual abstractions — can be warmed with feeling and made more pictorial. It was Goethe's genius, as both artist and scientist, to unite these two movements in one person, raising feeling to cognition and enlivening ideas with feeling. In doing so he pointed the way to what has been called Goethean science. Steiner summarizes his achievement this way:

> [When nature's laws] come to expression in the mind of a true artist not only as perfect pictures of things, but also as thoughts, then the creative source common to both [science] and art appears with special clarity before our eyes. Goethe is such an artist. (Steiner 2000, p. 210)

Of course, Steiner could just as well have said, "When nature's laws come to expression in the mind of the scientist, not only as thoughts, but also as pictures...." In any case, Goethe himself expressed the result of bringing the artistic and scientific impulses together:

> When healthy human nature works as a whole; when we feel ourselves within the world as in a beautiful, worthy, and precious whole; when harmonious satisfaction grants us pure and free delight, then the universe, if it were self-aware, would rejoice at having attained its goal, and it would marvel at the pinnacle of its own becoming and being. (Quoted in Steiner 2000, pp. 211-12)

There is no underestimating how uncomfortably Goethe's thought sits within the current scientific ethos. But there is also no underestimating the painful wrench required of us if science is to escape its ever more oppressive and dangerous dualistic inheritance. It is, after all, no wonder that Goethe's sentiment seems strange within a culture where abstract, computerlike head-thoughts run on in isolation from our beating hearts and muscular activity. Losing contact with the real being of nature, we create a kind of senseless, unfeeling, technological counter-reality of dumb but terrifying power, until finally we provoke nature beyond her patience to endure, and ecological catastrophe ensues.

Overcoming Alienation

If we are to transcend dumb power in our quest for wisdom, we will have to overcome the mutual alienation of mind, heart, and limbs. A mind cut off from the feeling heart becomes abstract and dead; limbs isolated from the heart become instruments of mere technical effectiveness.

The alienation of mind from body works in both directions. On the one hand, our thin and abstract thoughts do not naturally inhabit our bodies or find their appropriate, outward, gestural form. On the other hand, the inner, expressive aspect of the body's gestures and feelings does not easily light up in imagination and thought. Our bodies, in other words, are not plastic or responsive or expressive in relation to our thoughts and feelings. The conversation between inner and outer becomes stilted or non-existent. We do not learn the language of gesture that unites outer appearance and inner significance, and therefore we cannot think in images. We cannot think imaginatively.

And yet, our bodies are that part of the physical world with which we are surely most intimate! If we cannot make our own bodies the image and outer revelation of our thoughts, and if we cannot discover in thought the inner, expressive content of our outer, bodily gestures, then how can we expect the gestures of external nature to light up within us as understanding? Only through an artistically informed scientific training can the researcher intensify the imaginal and pictorial richness of her thoughts and thereby bring them into much more vivid relationship with the world's phenomena.

It may be difficult for many scientists to see the relevance of such training to their own work. So, too, it was difficult for many of Galileo's contemporaries to see the relevance of the telescope and of experiments with inclined planes to what they already knew about celestial and terrestrial bodies. The world's actual expression of itself loses its importance when one retreats into received metaphysical doctrine or the comforting certainties of mathematics.

Galileo achieved his revolutionary insights by uniting the human being as perceiver and artisan with the human being as thinker. Our task today is in some regards similar. We can further scientific understanding only by recovering the unity of our own being, which is also to recover our connections with the external world — that is, to recover the world as a world of full-bodied *experience*. The mutual alienation of science and art in our time provides a good measure of the scale of the task before us.

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NOTES

1. We should be open to the possibility that many of the great thinkers of the medieval era, while dealing with concepts divorced from any systematic, perceptual engagement with the world's phenomena, nevertheless thought much more deeply and incisively than we do today, and experienced a reality in their thoughts that has progressively been lost to us.

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(Continued from page 12)

Although glow-worms live in open-air grottos and sheltered banks throughout New Zealand and parts of Australia, the Waitomo caves provide unusually ideal habitat.

Since the larvae can only attract insects in the dark, the underground world provides uninterrupted "gathering" conditions. With so many shaft openings, insects are continually entering the cave system and flying through the fresh air that flows with the water.

Whether these potential food sources are simply drawn to the light of the glow-worms or mistake the brightness above for the night sky, they consistently fly upwards and become entangled in the fishing lines. The stillness of the air allows the lines to hang free without getting stuck together and also keeps the larvae from drying out as they would in windy conditions.

Glow-worms are remarkably energy-efficient, and can bio-luminesce for up to three months without eating. Their light is a form of phosphorescence, the result of a chemical reaction between ATP, luciferin, luciferase, and oxygen, in which no heat is given off. The larvae shining brightest are supposed to be the most hungry. Glow-worms can also survive a number of days submerged in water when the caves flood. Several months before my trip, however, two weeks of sustained high water had washed away the colony in the cave we were visiting. Slowly the population had returned to its usual massive size and brilliance.

Because direct light causes the glow-worms to go dark, after which it takes them several hours to regain full food-attracting brightness, we never actually saw the bodily form of a larva or an adult. We saw only their gleaming lights and the soft, dangling shimmer of their fishing lines.

Full of amazement, we put our tubes into the water, beginning the blackwater tubing portion of our trip. With our eyes fully adjusted and our bodies nestled into the buoyant rubber, we floated through the luminous darkness. Spinning in the current, we gazed at the subterranean sky above us, soaking up the magic as daylight dawned around the last bend.

We drifted on past our access shaft, riding some rapids and scrambling through dry side caves before walking back upstream to our exit. We replaced the tubes, then one by one clipped into the belay rope and climbed the pitted, vertical wall into the lichens and mosses, the ferns and fragrant warmth. The late sun shone deeply golden across the hills, somehow a more precious light in a more marvelous world than I had been aware of a few hours before.

Brain Activity and Conscious Experience

Siegward-M. Elsas

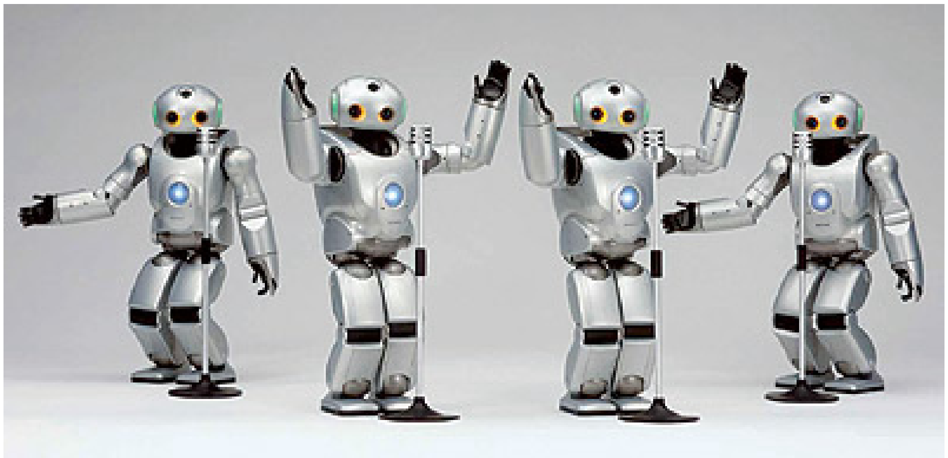

Figure 1. The Sony SDR-4X is a bipedal humanoid robot. According to Sony, the 2-foot-tall, 13-pound offspring of Sony's Digital Creatures Laboratory can recognize faces, learn new vocabulary, fetch things, and hold "nearly conversations." It sings and dances, too.

In 1780, Galvani simultaneously discovered electrical currents and laid the foundations of modern neurophysiology (Galvani 1791, p. 363). He found that frog muscles twitch when they come in contact with two different metals, and believed he had discovered the essence of life energy in electricity.

Since Galvani's day we have learned to use electrical technology to study brain function. We also construct robots, which are capable of sensing and recognizing their environment (as in voice recognition), and performing meaningful acts such as greeting guests or cleaning the kitchen (Figure 1). The question has arisen for many: is the human brain a sophisticated computer, and are we really robots? What would be the moral consequences for society if we thought of ourselves in this way?

Electricity and Physiology

If we connect a loudspeaker, a voltmeter or a monitor to the human body by means of several wires and skin electrodes, and use a good amplifier connected to an electric power source, we will detect some activity. Most obvious and easily recordable at almost any point on the body will be the electrical activity of the human heart. This activity is commonly shown in an electrocardiogram (EKG), and we can recognize its rhythmical activity as synchronous with our heartbeat and pulse.

In a similar fashion, we can record electrical activity from all muscles by proper placement of our electrodes. In contrast to the heart, which tends toward an even rhythm, the rhythmical electrical activity of our muscles, expressed in "action potentials," increases dramatically in frequency when we exert our muscle strength. For many patients, who have an electromyogram (EMG) performed for diagnostic purposes, it is quite an experience to see how their intentional effort is reflected immediately and accurately in the output of the loudspeaker or the EMG monitor second by second.

With more effort — for example, by placing needle electrodes properly — we can also record electrical activity directly from the peripheral nerves or the posterior part of the spinal cord. Again we find rhythmical activity, now at even higher frequencies than in the muscles, but in this case it is no longer synchronous with any outer movement. This recording can be quite painful due to the irritation of the nerves; however, the pain can give us further insight into the activity of the nerves. When we pinch the skin area around the nerve, we may find that the frequency of the electrical activity in the nerve increases according to the intensity of the pinch. Of course, the stronger the pinch, the more pain we feel. Thus, it seems that the intensity of our pain is reflected in the frequency of the electrical activity in the nerve or spinal cord. Feeling the pain is really a personal and internal experience, which cannot be observed from outside like a muscle movement. Similar observations can be made just from touching the skin. Maybe the pain or the experience of touch can be understood as an inner movement in the arena of our consciousness.

When another skin area is pinched or touched, unconnected to the nerve or the portion of the spinal cord from which we are recording, we observe no response. In this way, we find that the spatial organization of the nervous system closely reflects the functional organization of our body. Specific skin areas correspond to specific peripheral nerves, to specific portions of the spinal cord and brain stem, and finally even to specific portions of the thalamus and cortex (Figure 2). This phenomenon is referred to as the “somatotopic organization” of the nervous system. More sensitive skin areas are associated with a denser distribution of nerves and larger corresponding brain regions. Thus we can picture the ever-changing electrical activity along all these pathways in the nervous system as continuously reflecting both in frequency and in location what is going on on our skin.

With even more sophisticated recording techniques, it is possible to record electrical activity from our sense organs and the corresponding nerves — for example, the ears, cochlear nerve, and brain stem; and the eyes, optical nerves, thalamus, and optical cortex. We then discover how the properties of an observed external object (a flower, an animal, or another person) and of our inner sensory experience (a color or shape, a tone, a melody, or words) become immediately and accurately reflected in the frequency and distribution of electrical activity in the sensory system. In analogy to the somatotopic organization, we can speak of the “tonotopic” organization of the auditory nerve, medial geniculate region of the thalamus, and auditory cortex in the temporal lobe (Pantev and Lütkenhöner 2000), and likewise of the “retinotopic” organization of the optical nerve, lateral geniculate region of the thalamus, and optical cortex.

We can also record the overall electrical activity of the brain by placing electrodes evenly spaced over the entire skull. This recording is referred to as an electroencephalogram (EEG). We find a mixture of frequencies, ranging from about 1 wave per second (1 Hz) up to 16 Hz, and with more sophisticated analysis we may find activities up to more than 500 Hz. The most striking aspect of EEG patterns is their dependence on our state of consciousness. By far the easiest distinction to make from EEG recordings is whether the subject is awake, drowsy, or asleep. If he or she is falling asleep, we can tell exactly when he or she is becoming drowsy, possibly more accurately than by external observation. Again we find how the electrical activity of the brain accurately reflects our inner experience, in this case the state of our consciousness.

The Necessity of Nervous Activity

Taking together all these striking phenomena of nervous system physiology, we may arrive at a picture of nervous system function. In contrast to all other organs, which develop their own function in the body — for example, the lungs take in the air to refresh the blood, the liver builds up and secretes proteins for the blood, the kidneys filter the blood and secrete urine, the heart stops the blood flow and creates blood pressure — the nervous system does not have a separate function of its own. Instead, like a mirror it reflects in its activity everything else that is going on around it. In neurophysiological terms this is referred to as “representation.” The electrical activity of the nervous system — more precisely its time structure in many frequencies — reflects how and where we touch something with our skin; it reflects what we see and hear around us; it reflects the activity of our inner organs via the autonomic nerves; and it even reflects our intentions to move and what we feel and think. All these sensory experiences, reflected in the time-structure of brain electrical activity, are internal. We might call them “mental images”.

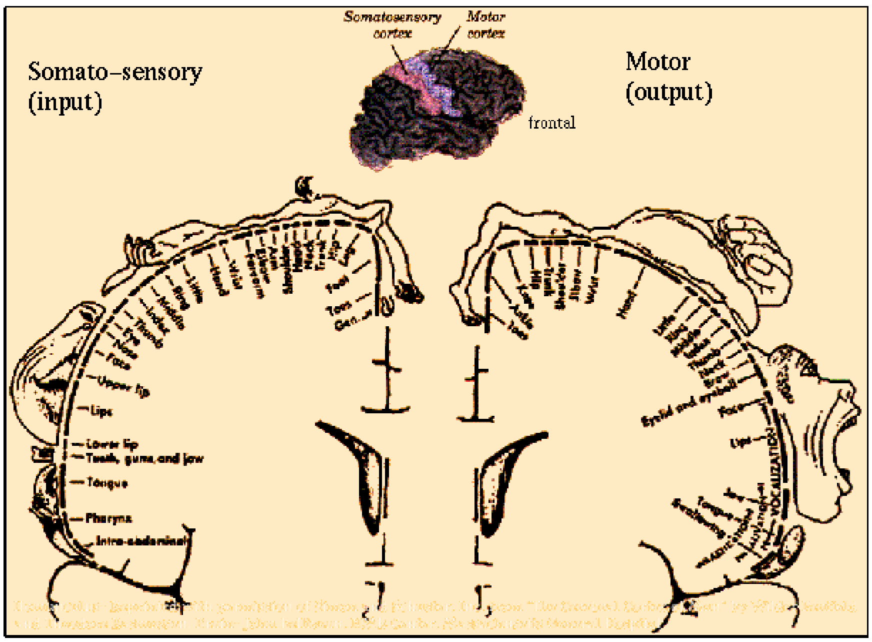

Figure 2. Somatotopic organization of somatosensory cortex (left) and motor cortex (right).

So we might be tempted to think that the electrical activity of the nervous system actually does have a separate function of its own, namely, to produce our inner experiences, or mental images, as well as our outer movements. This would be similar to how the liver produces proteins for the blood and excretes bile.

I will briefly examine this hypothesis. If it were true, then electrical activity of the nervous system would be both necessary and sufficient for our inner experiences and bodily movements to occur. First, then, we will look at the question of necessity. We need to eliminate all or part of the nervous system's electrical activity and see what functions are left. If the functions always disappear along with the electrical activity, then we can conclude that the electrical activity is necessary to the functions.

The body's electrical activity is based on the relative concentration of salts, specifically the difference between concentrations in the blood and concentrations inside the nerves and muscles. If this balance is disturbed by loss or increase of salts, or by a change in properties of the dividing membranes, global dysfunction of the nervous system results. It is similar to our experience of excessive deep breathing (hyperventilation): we may feel tingling of the skin, especially on the most sensitive areas such as hands, feet and around the lips; our muscles may involuntarily contract or be limp and cease to follow our will; and we may develop colored visual hallucinations or slowly drift into drowsiness and eventually into unconsciousness. In extreme cases, effects similar to those in our muscles may result in disturbances of heart rhythm and could cause death.

Local damage to nerves or brain tissue through injury or a stroke results only in the local loss of electrical activity in the nervous system. In each case, there is a specific loss of function related to the affected part of the nervous system. If a peripheral nerve is injured, we may lose sensation and muscle strength in the affected part of the limb. If the brainstem or cortex becomes damaged on one side, sensation and muscle strength may be partially or completely impaired on the other half of our body. Other specific cortical brain lesions may cause loss of vision, the ability to speak or to understand, or even the ability to recognize specific objects in the presence of good vision.

The loss of language comprehension in the presence of good hearing, or the loss of object recognition in the presence of good vision, could be described as an inability to form an appropriate mental image of the perceived sensory experience. The sensory experience remains raw, we are unable to connect a known concept to our percept. Apparently, the normal function of specific brain regions is necessary for the formation of specific mental images. In this regard, nerves and brain tissue appear similar to sense organs: when we lose an organ, we can no longer perceive objects via the particular sense quality or sensory area in question. In the case of the nervous system, we lose the ability to form mental images, and with it we lose the conscious awareness of specific aspects or sometimes the whole of an object.

A stroke in the primary motor cortex area (located in the precentral gyrus, or fold, of the brain) results in weakness or paralysis of the contralateral limbs; damage anterior to it in the supplementary motor area results in apraxia, the inability to perform learned complex movements such as brushing one's hair or teeth, using a hammer, or writing with a pen. Difficulty or inability to speak while still being able to use mouth and tongue, called aphasia, is a special example of apraxia from this viewpoint. One might say that in these situations we have lost the capacity to form a mental image of the intended movement. The situation is similar to what we have seen with the sensory regions of the brain: it appears that intact function of specific brain regions is necessary to form a mental image of the intended movement. Understood in this way, the motor regions of the brain are rather like sense organs for movement, since we need them in order to form the associated mental images. Without mental images, meaningful and conscious movements are impossible.

Taking this evidence together, we may safely conclude that electrical activity of the nervous system is indeed necessary for the occurrence of our inner experiences, body movements, and even conscious object-awareness.

The Sufficiency of Nervous Activity

We will now inquire whether in the presence of otherwise general health, electrical activity of the nervous system is sufficient to produce our inner experiences and body movements. To test this experimentally, we need to induce electrical activity in the muscles or the nervous system, and to do so in a manner as close as possible to physiological conditions.

When in a medical emergency someone's heart has "stopped beating," it may have stopped completely (asystole), or it may be caught in very small and fast contractions (fibrillations). The difference is apparent in the EKG. In the second condition, a strong electric shock by a defibrillator may stop the fibrillations and allow the heart to return to rhythmic contractions. In the first condition (asystole), the electric shock has no effect at all. So the electric shock cannot produce rhythmical contractions of the heart, but can only stop unrhythmical activity. A cardiac pacemaker, used for irregularities of the heartbeat (arrhythmias), has an effect only when the heart is already beating. Apparently, in the case of the heart, externally induced electrical activity can only modulate movement that is already present, but cannot initiate it.

Direct electrical stimulation of limb muscles will cause muscle twitches or sustained contractions, depending on the duration of stimulation, but no meaningful limb movements. Electrical stimulation of the peripheral nerves — for example, during diagnostic nerve conduction studies — is quite painful and will cause similar muscle twitches or contractions. In both cases, the individual who is stimulated experiences the induced movements as involuntary and as forced from outside.

Similar to the somatotopic representation of touch sensations in electrical activities of the postcentral gyrus of the brain, conscious movement is reflected in the precentral gyrus of the brain (primary motor cortex) in somatotopic fashion (Figure 2). When this region is directly stimulated by a small electrical current (a few milliamperes) — for example, during brain tumor surgery, or by transcranial magnetic stimulation (TMS) through the skull — muscle twitches or contractions similar to direct muscle or nerve stimulation can be induced. At the same time, voluntary movements are impossible during stimulation. Stimulation just anterior to this area in the "supplementary motor area" can induce somewhat more complex movements or even the sensation of an urge to move. However, such induced movements or sensations are always perceived as involuntary and as imposed by the experimenter.

Can induced electrical activity in the brain produce mental images and conscious experience? Most electrical stimulations of the awake brain have been and still are being carried out in the context of surgery in epilepsy patients to remove an epileptic focus in their brain. Stimulations of primary sensory areas can induce elementary hallucinations of being touched, buzzing sounds, light flashes, and so on. In contrast, stimulation of secondary and tertiary sensory areas, such as Wernicke's area, which is needed for the comprehension of speech, does not usually result in hallucinatory phenomena but mainly in a temporary loss of function. Stimulation of certain regions of the temporal lobe, including hippocampus and the entorhinal cortex, can induce complex feelings such as the sensation, "I have experienced this situation before" (déjà vu), fear, or complex visual memories. However, in each case the patient is aware that the sensation is not a spontaneous feeling or memory, but is artificially induced by the experimenter, and normal awareness of the surroundings continues. In many aspects, such induced experiences are quite similar to the "auras" that epilepsy patients experience at the beginning of a seizure. Epileptic auras tend to have stereotypical sensory or emotional content that does not match the sensory surroundings and that is outside the control of the patient.

Even in nonepileptic individuals, cortical stimulations can induce brief focal epileptic electrical discharges. Spontaneous epileptic auras are usually accompanied by electrical discharges in the epileptic focus in the brain. Thus, cortical stimulation and epileptic auras have in common that electrical brain activity occurs out of context. As we have seen above, electrical brain activity normally reflects or represents sensory or other internal experience. That is, it correlates with conscious or subconscious mental images. In the abnormal situations involving cortical stimulation or epileptic auras, internal experiences are elicited. However, in both cases the individuals experiencing the elicited mental images clearly recognize that the events or spontaneous memories or feelings are not real, but occur out of context, similarly to hallucinations.

The Brain's Role in Conscious Experience

Let us take together the considered evidence for the question whether electrical activity in the nervous system is sufficient to produce inner experiences and body movements. While induced electrical activity can indeed elicit movements and inner experiences, such induced movements or inner experiences remain fragmentary, and always have the character of involuntary or hallucinatory events. One might argue that this finding is only the result of technically imperfect stimulation. But another view, consistent with the picture of nervous system function developed above, would lead us to conclude that electrical brain activity in itself is not sufficient to produce meaningful movements or inner experiences. In this view, meaningful movements or inner experiences would require that external realities (such as objects or changes in our body) or internal realities (such as mental images or intentions) become reflected or represented in electrical brain activity.

Such a view would also be consistent with our own natural inner experience of our thoughts, feelings and intentions. We experience them as inner realities and not as hallucinatory byproducts of our brain. After all, we know very well that the content and direction of our thoughts are independent of our bodily organization. In thinking, we are able to arrive at truths such as 3 x 4 =12, independently of who has the thought, and of our physical and emotional state. In situations where our body does have an influence, such as when we are tired, drunk, obsessive-compulsive, or schizophrenic, our thinking becomes impaired. Usually we (or others) are then aware that our reasoning cannot fully be trusted.

Similarly, we experience our intentions as truly our own, and not as involuntary reactions of our brain. Again, in situations where our body does have an influence, such as when we are intoxicated or suffer from mental illness — in short, when we are "out of control" — we or others know that such actions are not in line with our well-considered intentions.

Thus, while we experience the process of thinking and our intentions as independent from our bodily organization, we know from electrophysiological (Rodriquez et al. 1999; Kornhuber and Deecke 1965) and functional imaging studies that our thoughts or mental images always are correlated with specific neuronal electrical activity and a corresponding local increase in blood flow in the brain. Thus it appears that the thinking process, just as all the sensory processes studied above, leaves an imprint or reflection in the brain. If the corresponding part of the brain becomes damaged or lost, we become incapable of forming the particular kind of mental image which is associated with that part of the brain — just as we lose the capacity to see when we lose an eye.

It seems, then, that the general rule of brain function holds: the brain does not produce thoughts or mental images, just as it does not produce the light of vision or the strength of our movement. Instead the brain serves to bring the thought or mental image to consciousness by allowing it to be imprinted. The brain in this sense might be compared to the sand that provides enough resistance to receive the form of a footprint:

> He who walks over a soft ground will imprint his footprints into the soil. One will not be tempted to say the forms of the footprints were pushed up from below by forces in the soil …. Similarly, he who observes the essential being of thinking in an unbiased manner, will not ascribe any part in this being to the traces in the body organization, which arise from the preparation of thinking for its appearance by means of the body. (Steiner 1967, author's translation)

That is, the resistance the brain presents to thought images may allow them to become conscious. In this way, the brain may serve as a kind of sense organ for thoughts and concepts that have an independent existence.

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For more about Siegward, see the article, "A New Affiliate Researcher" on p. 6 of this issue.

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On DNA Barcoding

Just before going to press we got word that a letter co-authored by Malte Ebach, a paleontologist at the Buffalo Museum of Science, and Nature Institute director Craig Holdrege appeared in the Correspondence section of the April 8, 2005 issue of the prestigious scientific journal, *Nature*. The letter dealt with the hope now being attached to "DNA barcoding" — the effort to identify a unique piece of DNA for every described species. The aim is to enable taxonomists to run large biotic surveys without having to learn about the organisms involved or use morphological keys.

Here is part of the letter as it appeared in *Nature:*

Barcoding is at best a technology that may be able to spot DNA diversity within physically indistinct species. But even at this level it remains a genetic key to identify known species, rather than replacing traditional taxonomic practice.

However, this quick, cheap technology is in competition with taxonomy for funding. What cash-strapped student will want to enter a field such as taxonomy that takes years to master and offers little or no job prospects? A budding barcoder — with no interest in biology, let alone taxonomy — can be trained in a fraction of that time, quickly disseminate their 'research' globally and look forward to a well-funded career.

DNA barcoding may seem progressive to those who use the word 'dusty' whenever the subject of taxonomy arises. But the work of taxonomists provides knowledge of the organism, not [just] a few possibly unique nucleotides. In any case, every barcode must be linked with a known, described specimen stored somewhere.

Given its high-profile launch, barcoding will almost certainly result in a plethora of newly 'flagged' DNA species that will never be formally described. One estimate is that it will take some 250 years for taxonomy to catch up with barcoding. True to form, barcoding has supplied an answer: 'DNA taxonomy' — cataloguing barcodes and assigning each to an unnamed species.

Traditional taxonomy cannot keep up with this 'diversity'. How long will it be until even the specimen is no longer necessary to 'understand' the organism.

You will find the complete letter at natureinstitute.org/txt/ch/barcode.pdf.

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