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tentative theoretical models? How can we guard against letting a theory prematurely determine what counts as data?

Can there be more than one CS? If so, what determines our membership in one or another? Genetics? Environmental conditioning? Neurophysiological types? Astrological signs?

Scientific studies correlating brain functions or neuropeptide concentrations with conscious experiences might offer limited help. It is not at all clear that the brain and body must do anything unusual in order for a person to relate to the CS. It may also be worthwhile to correlate anecdotal reports of dreams and psychedelic, transpersonal, or mystical experiences.

We may be in the position of fish attempting to form an idea of water. Perhaps the CS is hardly mysterious at all and as close as the nearest television set. Perhaps we should take Woody Allen's comment as a guide: "The only important questions about the Astral Plane are how far is it from Midtown, and how late is it open?" But I think there is more to it than that.

If we tend to live only on the surface of our apparent islands, we might have a lot of unexplored territory awaiting us. "Inner space," our own or collective, is accessable far more cheaply than outer space — and might be equally rewarding.

— ABB

IS Journal #9 Published

IS Journal* #9,** edited by Nik Warren, was published this past June. Contents for *IS* #9 include *Fractals Cast No Shadows* by Will McWhinney; *Bucharest: Three Weeks Later* by Andra Akers; *Boundary Crossing: Mental Space Pressure, and Pseudomorality* by Michael Ian Paul; *An Arabesque Regression* by Colin Gorman; *Erodynamics* by Ralph Abraham; *Beyond Economism* by Hazel Henderson and *Paper Hubrenga* by Mark Trayle and John Bischoff. For information on submissions to ***IS Journal, contact Nik Warren, Editor, at P.O. Box #112, 3250 Olympic Blvd., Santa Monica, CA 90404.

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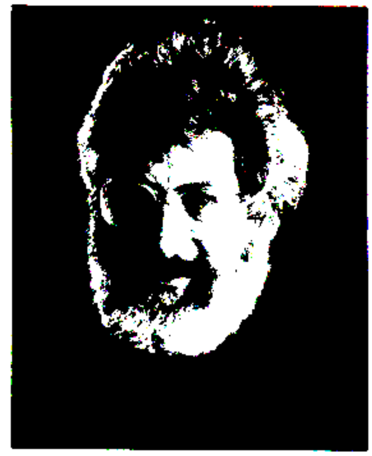
INTERNATIONAL SYNERGY INSTITUTE
1274 Calle de Comercio
Santa Fe, NM 87501

PROFILE: Faces Behind Ideas

RALPH ABRAHAM



Ralph Abraham, Professor of Mathematics at the University of California, Santa Cruz, has been a part of INTERNATIONAL SYNERGY INSTITUTE since its earliest days and a frequent contributor to the ***IS Journal***. The following material is excerpted from a longer interview with Ralph conducted by David Jay Brown and Rebecca McClen, one of a series of 12 planned for their forthcoming book, ***Voices of Vision.*** Portions of the longer version were published in ***IS Journal* #9.**

David Jay Brown: Ralph, can you tell us what it was that originally inspired your interest in mathematics and the mathematics of vibrations and dynamical systems?

Ralph Abraham: Well, I didn't get interested in dynamics and decide that's what I was going to study. It was just left foot, right foot, or some series of miracles.

It happened like this. I was an engineer and worked on a physics project, so I became a student of physics. Then one day a physics professor said in class that if you want to understand physics you have to study mathematics. So I changed to mathematics at that point. And I found a mentor, somebody who took care of me and helped me out, a wonderful man, Nate Coburn. I started studying what he was doing because he was my only contact in mathematics.

One reason I responded to his program was that it had to do with general relativity. Einstein had been a household word when I was growing up. My father respected Einstein very much. It was said that only eight people in the world could understand Einstein. My teacher apparently could and was writing in that field.

I had taken very few math courses during that period. I remember two or three very influential courses. One of them was a differential geometry course taught by Raoul Bott who became a very famous mathematician. Some concepts were included in that course that I later found useful in dynamics. So I had some math background, but not the kind of background I would have had if I'd done a Ph.D under a famous professor of dynamics.

Then I was looking for a job. I had one offer for some place where I didn't want to go and at the last minute, before the school year began, I got a letter from Berkeley offering me a job. In 1960 there wasn't any big mathematical center there, but of course I took it.

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Profile: Ralph Abraham

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After I got to Berkeley I was engaged in rewriting my thesis for publication. One day I discovered that they were having tea in some little room in the back of the building, and I had already been there for two or three months and hadn't met anyone. So I went to the tearoom to meet some people and to find out what was going on. And in this way I discovered a couple of people who later became my best friends in mathematics. Everybody had just arrived in September of 1960. Overnight, Berkeley had become one of the most important mathematical centers in the world — and I just happened to be there, apparently because of a clerical error.

One of the people I met that day at tea was Steve Smale. I was done rewriting and was looking for something new to do. So I said, "What do you do?" And he said, "Well, stop by the office and I'll show you." The next day I stopped by his office and we started working together. Later I found out that he was a really famous mathematician. He won the Fields Medal, which is the mathematical equivalent of the Nobel Prize, for doing the very work that he was showing me.

So I found myself on the research frontier in mathematics, working with some really wonderful people who all thought I was fine, because in this group there was no insecurity. It was just, "This is what we do and if you fit in, fine." So we worked together and had great fun. We had fantastic parties where we played music and danced and got drunk and we did a lot of creative work in what became a new branch of mathematics called "global analysis." And all this happened in just one or two years. Part of this program was "nonlinear dynamics" as practiced by mathematicians on the research frontier at that time, using tools called "differential topology." It's a far cry from what people are doing now under the name of chaos, nonlinear dynamics, and so on, that you read about in stories like Jim Gleick's book ***Chaos***.

All that I did in those early days was mathematical. It couldn't be explained to a lay person without some very hairy preparation, and I've tried to make that explanation possible in my four picture books, ***Dynamics, The Geometry Of Behavior.***

The third of these four books is devoted to "tangles." In 1960, Steve Smale and I would take turns at the board drawing these tangles and trying to make some sense out of them and figure out what was going on. Tangles are like the skeleton of a beast. If you go into the Museum of Natural History and there's a skeleton of a dinosaur hanging from the ceiling, you can walk around it and from the skeleton you can imagine the whole thing. But if you saw the whole thing you couldn't see the skeleton inside without an x-ray machine. It's just like a blob. These tangles are the skeletons of chaos. We didn't discover them; they were known to Poincare in 1882 or so.

In 1960 we were just trying to figure out these skeletons and relate them to the eventual behavior of all dynamical systems, which includes practically everything in the world: all kinds of processes, including the human process and the process of history itself. All these are dynamical systems, their skeleton are these tangles, and the tangles have aspects known under these words: fractal, chaotic, and so on. But they are much more: they are highly regular, they're dynamic, they're symbolic, they're mythical, and they're beautiful. In fact, they're mathematical.

DJB: Could you tell us how your travels in India and the experiences you had there have influenced your outlook on life and mathematics?

RA: What I had done that was respected by mathematicians in the way of frontier research work was ancient history by the time I went to India and lived in a cave. So, to answer your question, I should first of all identify what I've done since then that could be regarded as mathematical.

I would say that the computer revolution has presented enormous opportunities to mathematics, to the profession and to the individual mathematicians, which have not yet been seized. Many mathematicians have rejected the significance of computers, so far. But if we could say that experiments with computers represent mathematical research, you could see the evidence of my stay in India in the cave on my outlook on mathematics.

My computer experiments involve the concepts of vibration, harmony, resonance, and mathematical models for these phenomena. We would like to understand how a person is in morphic resonance with a field, if these metaphors have any function from a perspective of pattern-modeling, which is what I think mathematics is all about. The processes where this kind of metaphor is proposed — whether in the Indian Samkya philosophy or in Rupert Sheldrake's theories — are always in a living, biological, mental sphere. So the data, if there are any data, would necessarily be chaotic.

First of all we would have to extend or map the notion of resonance from the circular sphere, where the concepts first evolved, into the context of chaos. When you have two strings of a guitar, you pluck one and the other one vibrates by so-called sympathetic vibration. This vibration is understood as a non-chaotic phenomenon; it is just oscillation. Each point on the string vibrates, left, right, left, right, left, right.

So from this, which I'll call the circular or periodic domain, the concepts have to be extended to the chaotic. If the two strings were chaotic instead of periodic, which means they would sound raspy and noisy instead of harmonious and sweet, then could there still be a sympathetic vibration of one caused by the nearby chaotic vibration of the other?

I came back from India in January 1973. By January 1974 I was already involved in experiments with chaotic resonance, and this has dominated my research way up to the present day. For example, one discovery we made is that the Rossler attractor, which is one of the simplest of chaotic forms, does have sympathetic vibration as one of its characteristics.

After India I concentrated more on vibration and resonance, whereas before, we were involved with the general, skeletal structures of chaos. And they're related, in that the theory of chaotic resonance is based upon an understanding of the skeleton, the so-called homoclinic tangles, as I've tried to explain in my picture books.

DJB: Have your experiences with psychedelics had any influence on your mathematical perspective and research?

RA: Well, yes. I guess my experiences with psychedelics influenced everything. When I described the impact of India and the cave on my mathematics I could have mentioned that, because there was a period of six or seven years which included psychedelics, traveling in Europe, sleeping in the street, my travels in India, the cave, and so on. These were all part of the walkabout between

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my first mathematical period and all that has followed in the past 15 years. This was my hippie period, this specta-cular experience of the G.R. wave, or the Gylanic Revival (after Riane Eisler), of the Sixties.

I think my emphasis on vibrations and resonance is one thing that changed after my walkabout. Another thing that changed, which had more to do with psychedelics than with India, was that I became more concerned with the application of mathematics to the important problems of the human world. I felt, and continue to feel, that this planet is really sick; there are serious problems that need to be faced, and if mathematics doesn't have anything to do with these problems then perhaps it isn't worth doing. One should do something else. So I thought vigorously after that period about something I had not even thought about before: the relationship of the research to the problems of the world. That became an obsession, I would say.

DJB: What are some of the problems that you see with the present state of American mathematical education and how do you think improvements could be made?

RA: Well, I would say a good thing to do with mathematical education in the United States or in the world today would be just to cancel it and start over again from scratch, two or three generations later. The whole thing is in a really dangerous plight. And I've been saying this for years and so have other people, but only recently the problem has risen to a scale of national prominence where even the president and the governor and everybody's saying, "Well hey! Our gross national product might be threatened, because our people are no good at mathematics."

So we have a serious situation. First of all, mathematics is sort of akin to walking as a human experience. It's just really easy. I mean it shouldn't be easy, how can you tell somebody how to walk, you know? But people do find it easy and they naturally learn how to do it. They just watch, and by imitation they can do it. It's the same with mathematics! It's part of our heritage, all of us, to be genius at mathematics. It is a completely human activity. It involves the resonance between prototypical objects in the morphogenetic field and specific examples of similar forms in the field of nature, as they're experienced by human beings through the doors of perception. And as life forms a resonant channel between these two fields, it's just as natural as understanding anything, including walking, playing tennis, and so on. Mathematical knowledge is part of our human heritage.

Furthermore it's essential to evolution. Where there's no mathematical knowledge there can be no evolution, because evolution to a stable life-form requires a kind of mathematical, sacred guidance. This can be understood in many different images, the least controversial one being that there would be a harmonious resonance between all of the components, parts, sub-systems, and so on involved in the life process. Where there is an inharmonious resonance, or dissonance, there would be some kind of illness whether the organism is a snail, a human, a society, or the all and everything that we know by the name history. So the harmonious resonance maintained during the process of our own growth, or social evolution, evolution requires mathematical understanding. You may see the dissonance of the lack of mathematical understanding through the gross national product, or the number of wars, or the spread of AIDS, for example.

Another importance of chaos theory is in correcting a problem in mathematical education that has consisted, in part, of denial. People have been taught the nonexistence of some of the essential mathematical forms, namely, chaotic forms. This kind of denial produces an educated adult somewhat less capable than an uneducated adult.

Education which functions in this way is not the same as no education. It's worse, because it destroys intelligence, it destroys functionality, it destroys harmony with the resonance of the all and everything which is necessary for health. Our educational system, in short, is producing sickness and contributing to the global ecological problems on the planet by destroying the native intelligence that children have, the capability they have to understand the world around them in its complexity, in its chaos, in its resonance and harmony and love, destroying it through the inculcation of false concepts and through the production of avoidance mechanisms connected with certain mathematical ideas.

It's a very serious problem. One possible response would be to revise mathematical education so that, within the same system, one would try to provide teachers who are more highly trained. That could only make matters worse, you see, since the teachers are already highly mistrained. Many have already been taught to hate mathematics and so they can only teach hatred for mathematics. They don't really have any idea what mathematics is. For them, it's a knee-jerk response of this dark emotion, so retraining them more wouldn't help.

Rather than revision of the schools — which are full of false ideas and bad habits built into the field on a deep level — the most efficacious, practical solution would be the construction of a new educational system outside the usual channels of the school system. This is not too radical, as we have all been brought up to think of our real education as going on outside the school system. In school, for example, we do have music classes, yet if parents want their children really to know music, they provide a separate teacher outside the school. We also have religious instruction and dance instruction outside the school — anything that you really want to learn is studied outside of the school. And so also it may be with mathematics.

I think that one practical solution to this challenge to create a school outside of school would be a new breed of learning machines based on computers, educational software, and digital video. Even programs like Hypercard on the Macintosh, for example, could provide alternative education that could be approached by individuals without teachers.

So far, however, the creation of educational software has proved to be a very unrewarding activity for authors. And in spite of all different kinds of alternative funding agencies, nobody has seen this as a very important problem, although the National Science Foundation, the American Mathematical Society, and like organizations have convened conferences to discuss possible solutions of the crisis in mathematical education. The most promising alternative solution at this time has not been funded. And so there are very few existing alternatives for children now. Maybe after another generation or two there will be.

Ralph Abraham's video premiere in Los Angeles is October 13, 1990. *See details on page 11.*