

Reflections on My Collaboration with Francisco Varela

Humberto Maturana • Escuela Matriztica de Santiago, Chile • hmr/at/matriztica.org

> Context • Francisco Varela and Humberto Maturana worked closely together for several short episodes and wrote joint publications during the 1970s and 1980s. After that their respective paths in life diverged. **> Problem** • What is the common ground and what are the differences between these two authors with respect to their lives and aims? **> Method** • The author reconstructs their common history in the form of personal reflections and conversations with Varela. **> Results** • The personal reflections reveal the intellectual path Maturana took to develop his way of thinking, in particular his fascination with explanatory processes and the phenomenon of life. The conversations with Varela portray him as a man of great “cognitive autonomy,” whose career started with the intention to study “psychism in the universe.” For Varela it seemed possible, through meditation, to reach transcendental reality as something that exists externally to the living of human beings and that can be known as such. Maturana, by contrast, claims that there is no way to refer to such a universal truth. Rather, human beings generate all the worlds they live in. **> Implications** • While the two men collaborated in both teaching and writing, they eventually created two different constructivist approaches driven by a different set of questions. **> Constructivist content** • Both Humberto Maturana and Francisco Varela have decisively contributed to constructivist approaches. **> Key words** • Transcendental reality, truth, autopoiesis, formalization, perception and illusion.

THE LIVES AND WORKS OF FRANCISCO Varela Garcia and mine appear interrelated in our publications. In this essay I want to present my reflections about the history of our collaboration in the form of five or six reflective conversations that I have had in relation to it: four of them with Francisco and the others with myself.

First conversation with Francisco: Psychism in the universe

Francisco arrived in my lab in 1966, when I was a young man, 38 years old, and he was a young man of 20. He came from the Catholic University, where he had been studying medicine. He was sent to me highly recommended by Professor Juan de Dios Vial Correa, who was a friend of mine. When this young man arrived, I received him in my laboratory at the Medical School of the University of Chile. When we began to talk I was wondering if I would accept him as a student or not. In fact I liked to listen to the students when they came, letting them pres-

ent themselves without me interfering. He told me his life history, what he liked to do, and what was doing in academic terms; he spoke about his studies in medicine and his interests in philosophy and mathematics as well as his former affiliation to the Catholic Action Movement and his present one to the Communist Youth. He said that he liked to belong to some philosophical tradition. At some point in the conversation I asked him to tell me “What in fact is your fundamental desire in life?” His answer was: “I want to study psychism in the universe.” I thought for a long moment and said: “Excellent, you have come to proper place. But you will begin by studying vision in the frog.” Thus I accepted him as my student in my laboratory.

Now, as I was making some reflections in preparation for this conference, I asked myself “Why did I accept him? What did I hear? From where in my own feelings did I dare to accept him to come into my domain of existence?” To answer this question, I must say a few things about myself in my history so that you may know what kind of person I was then, and possibly am still.

Personal reflections I: The man who accepted Francisco as a student

I am Chilean. I was born in Chile to a mother who was a social worker. As a child, my mother had lived as an Indian girl in the Andes. She had been rescued in a popular riot in La Paz, Bolivia, and eventually discovered and recovered by her mother with the help of the Catholic Church. In the interim, she lived as a Quechua Indian girl in the highlands of Bolivia. This had consequences. Of course, I am not here to tell you the life history of my mother, but her history is central to my own. When she returned to Chile, she was a wild Indian girl, and she must have been thinking as such. Many years later, when she was more than 80 years old, I asked her what was the most important thing that she had learned from that time. She thought for a moment, and then said “to collaborate and to participate.”

I was the son of this woman. I was an ordinary child, and like every child I was interested in animals and plants; my mother supported these interests. So as I was growing

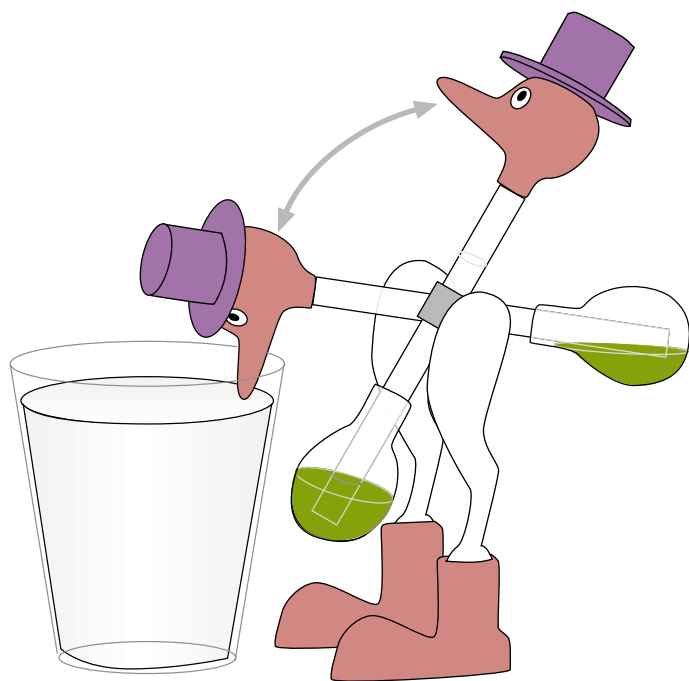


Figure 1: A drinking bird. (Drawing by Pille Bunnell).

up, I was curious about animals and plants, and my mother never objected my curiosity, on the contrary, I was always supported by her. Among the things that happened to me when I was growing up was that I had tuberculosis, so I stayed at home in bed for a lengthy period when I was 10. My mother worked, but a neighbor helped us, preparing food for me. I had paper, scissors, and glue and, as I liked to do things, I made animals, airplanes, and houses with them. As I was ill, I was mostly alone at home. I remember I had a cat that died, and I asked myself the question: "What is living that dies? What is 'to live'?" What is life that dies?" I saw that life and death went together. "Are stones dead? No," I said to myself, "they are not, so do they not die?" I was a child that could die of tuberculosis. Death was present for me and I was asking about myself. I wanted to know what *was* life, what was living that dies.

I came out of bed and went back to school, but eventually I had TB again and spent several more months at home in repose, thinking, ... dreaming. When I was 18 I was apparently healthy again and able to return to high school. I finished the last

year and entered university to study medicine. By the end of the first trimester, I was more seriously ill with lung tuberculosis and had to be hospitalized. This time I thought that my illness was without return. When I was in the hospital someone made me a gift. It was a toy bird that, when one put it besides a glass with water and inclined its head so that it touched the water with its beak, would stand up and oscillate, lowering its beak as if it were drinking in a never ending repetitive process. You may have seen this beautiful toy. All you need is a glass with water and to touch the bird's beak to it and let it "drink." After a moment the bird raises its head, oscillates, lowers its head by itself, "drinks" ... and the whole process repeats again and again indefinitely while there is water. I found this to be marvelous. I liked to make things myself so I wanted to know how it worked. I examined the bird carefully. It consisted of a bulbous body, a long neck, a round head with a beak, and it had a feather on its head and feather as its tail. How was it that this toy bird was doing what it was doing? What was the inside mechanism that made it do what it did? I could not see how it was inside because its body was painted

dark. Naturally, as a person that as a child liked to make his own toys, I realized that in order to know how it worked I had to look inside. I wanted to look inside but didn't want to damage it. I was in a quandary: if I didn't look inside, I wouldn't understand it; but if I did look, I would destroy it.

Eventually, I did look inside. The way this kind of toy works is that the beak and the head are covered with a material that easily absorbs water by capillarity that then evaporates as the bird oscillates. As the water on the head evaporates its temperature diminishes, the gas inside the head contracts, the gas that is in the belly expands, pushing the liquid in it up through the neck, the head becomes heavier and falls until it touches the water in the glass again, the liquid inside the head then goes back to the belly through an internal tube that extends below the liquid level in the body, the pressures of the gas in the head and belly equalize ... the bird begins to oscillate again ... and it all repeats. The result is, in principle, an eternal movement that lasts as long the configuration of the structure of the bird and of the features of the medium are conserved.

The beauty of such a toy is that it was very easy to see and understand that its movement as a bird occurred in an operational-relational domain that was completely different from the operational-relational domain in which what was taking place inside the bird? To find that out, I had to wait for an accident, which was that the bird fell and broke, and I discovered that what was inside it was ether.¹

What happens with this object is nothing extraordinary, even though it is fantastic. On the one hand, as a toy, it exists in a child's relational space as a spontaneously active entity that once it starts could go on forever. At the same time, the domain in which the toy operates as a relational totality is entirely different from the operational-relational domain of the internal dynamics structure that gives rise to that which makes that movement possible. That is, it is not possible to deduce from what you know about the inside

1 | Modern versions of this "drinking bird" toy use dichloromethane. The toy can still be purchased and is used as a demonstration of a heat engine.

what will happen with the resulting totality. Similarly, looking at the behavior of this totality you cannot deduce what is occurring inside it. You can only correlate what happens in these two domains if you observe at the same time both the operation of the inside and the behavior of the totality. Yes, of course a person can propose an explanatory process that looks like a deduction, but what she or he is doing in that case is a historical correlation by saying something like: if A happens in A', I always see that B happens in B'. Deductions and correlations are different reflective operations: deductions reveal structural coherences, correlations reveal historical coherences.

After several months in the hospital, I was treated with Streptomycin (which was beginning to be used in tuberculosis) and I began to recover. At the end of the year, I was sent to a recently inaugurated sanatorium in the Andes where eventually I was considered to be finally healthy again. I had two years of "meditation-retirement." Although I had to be in total repose I read secretly the *Magic Mountain* of Thomas Mann, *Thus spoke Zarathustra* by Frederic Nietzsche, and a book by a very distinguished biologist, Julian Huxley. This book was *Evolution: A Modern Synthesis*, which was published in 1942 and in which he describes and supports the vision of biological evolution based on natural selection according to the thinking of Charles Darwin. In this book, Huxley has a last chapter in which he asks himself two questions: one about whether there is progress in evolution, and another about what would constitute such progress. In this last chapter, Huxley makes a very beautiful biological analysis of the manner of living of different kinds of organisms, aiming to prove an evolutionary history of progress in them. And in this process, he proposes that progress consists in a history of increasing independence of the organism from the medium, claiming that the most progressive organisms were we human beings. I thought that that could not be! There I was, a human being belonging to the most advanced or progressive biological form, and yet I was totally dependent on the medium that supported me. I knew that if I were to leave the sanatorium I would soon die of TB! So I entered into a reflective discussion with Julian Huxley.

(Please, do not become impatient; all that I am saying has direct relevance to how was I thinking and feeling when I accepted Francisco Varela as my student while I did not have any need or obligation to do so.)

After reading Huxley, I began to think about what may be proper to the history of transformation of living systems if it was not progress. Imagine this young man that wanted to be a biologist (who was twenty years old then, barely out of secondary school) lying in bed all day, allowed to stand up only to go to the toilet or to sit up to eat, otherwise remaining always at rest. Accordingly, I thought that the only thing that could be proper and of significance for the living of a living being was to be itself living as itself. Namely, I realized that what is significant for a fly is to be a fly flying, and what is significant for a dog is to be a dog dogging: flying is what makes a fly a fly, and dogging is what makes a dog a dog. "And what is it that makes a human being a human being?" I asked myself. I had all the days and weeks to reflect, and eventually I realized that what makes us human beings human beings is that we are intelligent

(reflective), sensitive, and understanding being (person). But my fundamental biological insight in all this was that I also realized that

living beings were autonomous beings that did all that they did in the conservation of the realization of their living while the medium offered them the conditions that they required for the realization of living, and that otherwise they would die. For example, I said to myself, if I were to grab the tail of a dog and pull it, and the dog were to turn and bite me, I should not consider that the dog was attacking me. I should rather see that the dog was being itself, recovering its harmony in the realization of its living after having been disturbed by my pulling his tail. So, I realized that living beings were dynamic systems that realized themselves being themselves as autonomous discrete entities.

Being an autonomous human being consists in realizing oneself in the process of living as a human being.

As it turned out, I did not die, and I went back to medical school. There I had the chance to work with monkeys in an experimental study in the physiology course, and I decided to study learning in them. I wanted to find out how long it would take a monkey (*Macacus rhesus*) to learn to distinguish between a square and circle. Thus I prepared an experiment with two equal bowls, into one of which I would put some food and then cover them both with lids that differed only in that one had a square painted on it and the other a circle. The experiment was set in such a way that a monkey could see the bowls and reach a hand out between the bars of its cage to open the lid of one bowl and get food. I interchanged the lids randomly for each trial, but I always put the food under the cover with the same drawing. I counted how many trials the monkey required in order not to make mistakes in choosing the bowl whose lid had the figure on it that I had chosen as positive. At first

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it looked for where food might be recklessly, but eventually it only reached for the drawing that was treated as positive. It took the monkey 29 trials in order to make the proper choice regularly. I said to myself, "Fantastic. It takes the monkey 29 trials to distinguish between a square and a circle." And then I wondered whether distinguishing between a cross and two parallel lines would be more difficult, yet it took the monkey only one.

I found this wonderful. Maybe the monkey had never had any difficulty in distinguishing between the square and the circle, even though it appeared that it required 29 trials. I thought that after all monkeys have visual systems similar to ours and must see as well as we do, and should have no difficulty with visual distinctions of forms. Maybe what the monkey was learning was not to distinguish between a square and a circle, but something entirely different. Maybe, I thought, he was learning instead that I am always consistent. So I said to myself, "That

is what the monkey was learning, a general law of the universe: the ‘universal inertia’ – the universe is consistent with itself in its continuous change, every situation in the universe is consistent with ‘itself’ most of the time, and one can see that the changes that it undergoes result in transformations that arise around the conservation of the coherences of being itself.” How all that happened I did not know then. But I thought that living could not be different.

I continued my studies in medicine, and eventually had an opportunity to go to England to study anatomy. As it turned out, I was never accepted officially as a student in the University College of London, and I lived two years and six months there as an “invisible” student, working with Professor John Zacharias Young. After that I went to Harvard where I was accepted, and eventually obtained my PhD in 1958 and then spent two more years as a Post Doctoral Student at MIT. I returned to Chile in 1960 as an assistant in the department of Biology of the Medical School of the University of Chile as a 32-year-old young man, believing that I could learn anything. As an assistant, I was assigned to teach five lectures in a course of biology dealing with the origins of living systems. During my last lecture a student raised his hand, and said: “Sir, you say that living systems began on earth about 4,000 million years ago. What began 4,000 million years ago so that you can say now that living systems began then?”

And there I was, so confident in myself, and I suddenly realized that I could not answer such a question. I blushed red three times. And then I replied: “I cannot answer this question now. But if you come back next year, I will give you an answer.” I gave myself a whole year to think of an answer.

To accept a question is a very interesting thing. The question defines the domain in which the answer must be provided. So it is important to consider what question I heard. I heard the question of what it was that began four thousand million years ago and has been conserved through all those years right to the present so that you can say now

that living systems began then. I don’t even know who the student was, yet I know that he was a first year medical student. Furthermore, the question that I heard might not be the question he asked. But the question that I heard implied the idea that whatever made living systems living must have been conserved for 4,000 million years. To answer such question I should have known at that time what makes living systems living, but

I did not. Only if I could say in the moment that I heard the question what kind of systems are living systems, would I know what it was that began four thousand million years ago.

The other thing that happened to me in those reflections was that I realized that I had to think in terms of processes. Thus I realized that I had to look for the processes that gave rise to living systems, not when “life” began. There is no doubt that living systems exist as discrete dynamic autonomous entities and that each one of us exists as an autonomous singular dynamic molecular being, but how? I realized that what I had to find out was what was happening in the inner operation of a living system

that results in its being a living system. So I reformulated my question in the following manner: “What molecular processes should be taking place in a dynamic system so that if I looked at the result of their operation, I would see a living system?” Accordingly, I began to look at the inner processes that take place in a living system, trying to see how it was that as a result of their operation I saw a living system. At that time scientists spoke mostly about “life.” This was in 1960, and there was a general feeling that life was some kind of mystery that we might never understand. If one tried to characterize living systems in terms of their molecular components such as proteins, hydrocarbons, and amino acids, how would one ever know whether that list was complete? Similarly, if one tried, as many biologists did then, to characterize living systems in terms of their relational-operational properties such as growth, re-

production, adaptation, evolution, etc., how would one know when such a list was completed if one did not know before hand how living systems were made as living systems? I did not know what kind of systems were living systems but I saw, and biologists saw, many kinds of them all around. So I began to ask myself: What kind of molecular processes must be taking place now in all those entities such that the result is that I see them as autonomous living systems? What is the configuration of molecular processes that if it is continuously taking place, the result is a living system, that is, a dynamic system operating as an autonomous dynamic entity that is “concerned” only with its own realization, in such a way that if it stops, the living system dies?

I began to look everywhere for that configuration of molecular processes and for the way that it was conserved. Luckily, I had a friend whose laboratory was decorated with large charts depicting the cyclic metabolic processes that were then known to take place in cells. There were relations between glucose, proteins, aminoacids, and adenosine triphosphate (ATP), all interlaced in circular processes. And, of course, as I was talking with my friend I was telling him that what I wanted was “to show what network of molecular processes made a living system an

autonomous unity.” And as I did that I began to draw on his blackboard while saying: “Here, the nucleic acids participate in the synthesis of pro-

teins ... which then participate in the synthesis of nucleic acids... and...” – “This is it!” I must have shouted at that point. What I realized at that moment was the basic nature of the closed dynamics of production in which all the molecules that constitute a living being participate. And I also realized that the result of that closed dynamics of molecular productions was the spontaneous arising of an autonomous discrete entity that lasted as long as that closed dynamics was conserved. From then on, I began to talk of living systems as closed systems or as closed networks of molecular productions that resulted in themselves. I was avoiding functional relations as these obscure everything and do not let us see what processes are taking place. I did not have the concept of

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circularity or *self-production* yet; that came a little later. I did see then that everything in the living system maintains a set of circular molecular relations in a manner that spontaneously constitutes a living system as an autonomous discrete entity. Indeed, I had come to understand that living systems were discrete dynamic molecular entities that existed as closed circular networks of molecular productions that through their interactions produced the same closed molecular network that produced them, and in which all could change as long as their close circular dynamics of molecular productions remained invariant.

At the same time, I had also begun to do research on the nervous system. I wanted to see how perception happened as an operation of the nervous system. I was then studying color vision, and I wanted to show how colors characterized in terms of spectral energies were coded in the retina of the person that recognized them. I had set up my experiments in those terms because in those times it was thought that "living systems received through eyes the information about colors in the medium and coded it in the activity of the retinal neurons to be decoded afterwards in the central nervous system." I did many experiments and learned much about the activity of nerve cells. However, I could never show what I thought I should be able to show, namely, that the activity of the retina correlated with the spectral composition of the colors projected on a screen. I spent three years doing this. Eventually, I thought that maybe the question I was asking was wrong. Maybe the activity of retina did not correlate with the colors in terms of their spectral composition, but rather it correlated with the name of the color. My colleagues thought that I had become crazy.

But really, it was not such an insane idea. We know that we have illusions now and then. And when do we know that we have had an illusion? In daily life we say that an experience that we live as valid in the moment that we live it was an illusion when we invalidate it afterwards as we compare it with another experience of which we choose not doubt. For example, I may be walking in the city and see my friend John from next door across the street ... as I start to greet him, I see something in that person that makes me realize that was not John after all

but someone completely different. But when I saw John, I lived in my feelings my encounter with John. It was when I looked again from different perspective or inner attitude that the person across the street stopped being John and appeared to be somebody else. The possibility of correlating what happened in the retina and what happened in the rest of the nervous system when we see something with a name was not so crazy after all. We speak as if a name were something abstract, external to us, and do not realize that the name refers to our feelings in the experience that we are living. Calling a person "John" or a color "blue" refers to what is happening in oneself, not an entity supposed to be out there. So, when I name something, I am referring to what is happening to me, to an internal dynamics of my nervous system. Thus, when I proposed to correlate the activity of the retina with the name "of the color," I was proposing to correlate the activity of retina with the activity of the rest of the nervous system that generated the act of naming. In doing this, I began a new series of experiments to show that the activity of retina correlated with the name of the color. I was able to show this using a Skinner box and recording the activity of the retina using miniature electrodes.

A friend trained a pigeon to peck different spectral colors for which we had standard names such as green, blue, red, etc. The pigeon would, for example, peck at whatever we called "green", regardless of whether it was spectral green or a "color shadow" that we called green, even though its spectral composition was that of white light. This kind of experiment showed that the activity of the retina in chromatic perceptual experiences correlated with the name of the colored object, not with its spectral composition. And it showed at the same time that the nervous system operated by performing internal correlations in which a name corresponded to a configuration of activity in the central nervous system.

So, there I was: I had realized that what constituted living systems as living systems

was their continuous operation as a discrete closed network of molecular productions, and at the same time I had found that the nervous system as a network of cellular or molecular neuronal elements operated as a closed network of changing relations of activities within itself with no relation to an external medium. But if that is so, I asked

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myself: "What is that which we call the external world? And how do we know it if indeed we know it?" We live all that we live as valid in the moment in which we live it, and we do not know if we shall later say that we lived an illusion or a perception. For example, we can be in the circumstance of having

been living with someone for years being happily loved, and one day this person tells us that she never really loved you, and we begin to live our previously happy years as an unhappy past. If our present changes, our past changes too. Under these reflections I asked myself: "What is cognition? What is 'to know'? What is that which we distinguish when we make a distinction? And "What is it to make a distinction?" All these questions launched me even further into the most basic mystery of our human life: language and cognition as biological phenomena.

This is where I was when Francisco Varela came to me.

The two of us: Our beginning

The person who received Francisco Varela, accepting his desire to study "psychism in the universe," was a person who had a history of reflections that was not ordinary, and who could understand him in his particular deep desire. I saw in Francisco a passion that would not be abated by difficulties, an uncanny and daring openness to ask impossible questions, and a subtly reluctant disposition to accept reflective guidance. I liked him for all this. I liked his trust in himself and thought that I would like him to be first my student and later a member of my laboratory. He was a very interesting,

serious, and imaginative partner in reflective conversations. We were living a very particular time in biology and philosophy. For the first time in history, it was possible to talk about living beings referring to their manner of constitution without having to invent some transcendental explanatory principles. After he became my student, Francisco began to come to me at unexpected moments asking basic questions that led us to practice the art of reflecting about what different systems of thinking said and about what were the explicit or implicit notions that gave them validity according to their supporters. I had asked Francisco to repeat in the laboratory some classic experiments in vision in the understanding that whenever one repeats the work done by somebody else, new nuances appear which constitute new opportunities for reflection. We had very enriching philosophical and scientific conversations.

Francisco stayed with me for one year and six months before he went to the United States to work on his Ph.D. at Harvard. I visited him and talked with him whenever I went to the USA during his two years at Harvard; I recommended him highly in my publications; I introduced him to Professor Heinz von Forster, who liked him very much because Francisco was a good mathematician, perhaps more a mathematician than a biologist. He was very successful, completing his PhD in only two years, and he was well liked, indeed people became enchanted with him as he was a good colleague, established good relationships, and brought new ideas to many people.

Second conversation with Francisco: Formalizing autopoiesis

Francisco returned to Chile in 1970 and came back to my laboratory, wondering what I had been doing during the two years he was away. So we talked much, and I showed him again what I had been doing in the medical school since 1960 up to 1970, expanding on what I had been doing after he went to Harvard.

Shortly after that long conversation I went to visit a friend, José María Bulnes, who was both a historian and a philosopher. He was writing an essay about the dilemma of Don Quixote de la Mancha who had to decide for himself whether to become a wandering knight or a writer of novels of knighthood. Don Quixote decided to become a wandering knight, and, as my friend put it, he chose the praxis of being a knight over the "poiesis" of writing. At that moment I said aloud: "That is the word I need; that is the word I was looking for." Living systems are molecular systems that produce themselves, namely, they are molecular autopoietic systems. Autopoiesis is a perfect Greek neologism, not a mixture between Latin and Greek. In youthful vanity, I thought I had invented this term, but it turns out that Aristotle had also used it. Next day I told Francisco that I had found the word that I needed to refer to what made living systems autonomous entities.

And this is when my second conversation with Francisco took place. He said to me: "If you are right in what you say about living system we should be able to express it all in formal mathematical terms." At the time of this conversation our ages had changed: I had become 42 and Francisco 26 and he was no longer a young student. I said to Francisco "No, one does not formalize what is there, one formalizes what one thinks is happening. Formalizations are attempts to represent what we see as a phenomenon, not what is actually happening in what we think that we observe. What I see is what I think is there, what I think is happening in what we see." I continued: "If we want to formalize what happens in living beings, we need first to write a full description of the processes that we claim are taking place in them such that the result is that we see living systems appearing in front of us." And then I added: "I invite you to write this with me." The result of this endeavor is what we published as the little book, *De Maquinas y Seres Vivos* (About Machines and Living Systems). I wanted to name the book "Autopoiesis, the Organization of the Living", but I was not there at the moment of its publication, and Francisco thought that the

title that we eventually used was better for the circumstances of its publication.

As I said above, that was a very interesting moment in the history of biology. For the first time it had become obvious that the reason that the question about the essence of being, or about reality in itself, could not be answered without inventing some transcendental entity or process was due to the biological nature of the phenomenon of cognition and not due to some particular human limitation. And at the same time, it was becoming obvious that it was always possible to answer any question about what we do when we make a distinction. So Francisco and I had great conversations in which he showed his perceptiveness and insight in matters of mathematics and philosophy. In spite of our discrepancies, those were the best times that we spent together.

Personal reflection II: Formalisms and operational domains

Dear readers, you are molecular autopoietic systems. The notion of machine, as Francisco used it, does not mean to refer to a plastic, metal or electrical systems; it refers to the notion of structural coherence with the stability of the manner in which something is made. It is a way of saying that a system operates according to the characteristics that appear as we distinguish how it is made, and it is not a reductive assertion. Saying that living systems, like machines, are structurally determined systems is a way of saying that living systems operate according to the operational-relational coherences of the way they are made.

I did not like then, and indeed still do not like, formalizations. One formalizes that which one thinks is the case: formalizations follow the thinking of the person that makes them, as is apparent in the fact that every formalism, whether it is in mathematics, philosophy or technology, stands as a logical construct developed as the result of accepting some set of *a priori* premises. The formalization enables one to compute the consequences of the operation of those premises. In geometry, one specifies certain premises under the form of certain axioms to then follow the consequences or implications of

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the processes to which their use gives origin. In the proposition of a theory, the observer formalizes some abstractions from his or her experiences or reflections in relation to the matter under his or her consideration that he or she henceforth uses as basic premises that define the operational-relational coherences of all that he or she does in that domain. Those basic premises are accepted as given, even though they were in fact created as an arbitrary act of abstracting regularities from what the observer thinks that happens in the domain under his or her consideration. If the abstracted regularities are indeed basic, they will indeed permit the observer to create a system of reflections that may facilitate his or her operation in that domain. We human beings are expert in abstracting configurations and regularities in our different domains of living.

A few years earlier, I had realized that the nervous system operates by abstracting regularities and configurations in its own activity. This is why I was able to claim that the monkeys were detecting general laws of universe. They were not learning the particularities of what I was doing with them but rather the operational-relational configuration under which I was working. Whatever the set up that I presented them, they trusted the "law," "Maturana is consistent in what he does with my food", and they acted accordingly.

So I don't like formalisms, but I am interested in basic premises and systems of thought.

At this point the Chilean Military coup happened. I was not politically involved, but Francisco was. For him, what was happening was a very important event that changed the course of his life. For me, the military coup was an historical event that I had to live through. Although I was more aligned with the left, the political events did not affect me as they affected him, and I thought that I could slide through it without having any special presence. I felt that I had a responsibility to the students as a Professor in the Faculty of Sciences, and I thought that it was possible for me to continue my teaching in a political blind spot of the military if I did not talk about our political contingencies. In any

case, this was the general attitude at the University of Chile. The University of Chile was, as ever, providing me with space, salary, and facilities do whatever I believed deserved to be done. I had autonomy to teach and do research, if I was apolitical.

Therefore, when the military coup came, and Francisco left Chile at the end of 1973, I decided to stay. I wanted to know what it was like to live under a dictatorship. There had been dictators before in Germany, Italy, Russia, etc., and people said afterwards: "We did not know much of what was being done." Were they being blind, or were they lying? I wanted to see for myself how blind I could become.

Francisco went to Costa Rica, then to Oregon, and finally to Boulder Colorado, where he met the person who was to become his Master in Buddhism. His inclinations had become progressively different from mine, or mine from his. In the meantime I remained in Chile, following the operational-relational consequences of the facts that living systems existed as autonomous entities as closed molecular autopoietic systems, and of the fact that the nervous system operated as a closed network of changing relations of activity between its components (neuronal). And I did this in the attempt to understand how the nervous system was integrated in a living system that operated as a totality, that is, as an organism, in its niche. In doing this I followed the consequences of the biological facts that living systems as molecular autopoietic systems are structure determined systems and that as biological beings do not distinguish in experience between perception and illusion, and I asked myself: What are names that they make things appear in our relational living as entities about which we can talk? How is it that we can talk about ourselves as structure determined systems if in experience we do not distinguish between perception and illusion?

If we accept the biological fact that we are structure determined molecular autopoietic systems, three operational-relational domains become apparent to us when we attend to the way our living occurs. First, we can see that there is what we call the domain of the internal processes that occur in

the realization of a living being as it arises as an organism while operating as a totality in its niche, internal processes that occur as a dynamics of continuous structural changes around the uninterrupted realization of the autopoiesis of the organism. Second, we can see that there is what we call the operational relational domain in which the organism operates as a totality. And third, we can see that there is the operational-relational domain of the organism-niche unity that exists as a whole of coherent structural changes around the realization and conservation of the autopoiesis of the organism. While Francisco was abroad, I had realized that our personal relational living occurred in a semantic dynamics, that our living as human animals occurred in a non-semantic structural dynamics that made possible our personal semantic living, and that these two aspects of our human living occurred as interrelated in such a way such that if in the course of our epigenesis either one of them changed, the other changed too. And I realized, too, that all the different things that we do as human beings in the networks of conversations that we live in our semantic living, alone or with others, arise in the course of our congruent structural transformation in our living together as languaging beings.

Third conversation with Francisco: Writing The Tree of Knowledge

Francisco returned to Chile in 1980 after being abroad for seven years, and was immediately incorporated as a professor in the Faculty of Sciences. I received him happily in my laboratory and we begun planning what we would do. When he arrived, we were very short of money in the laboratory, and we decided to apply to some willing sponsor for a grant. The Organizations of American States (OAS) had made some signs of good will. I had a friend, Rolf Behncke, who worked for the government at that time and was willing to help us in making the right contacts.

The OSA had found that they had a problem with the transfer of agricultural knowledge. They would send emissaries to various locations to teach the peasants there what they considered to be better agricultural practices. The beneficiaries of the

One does not formalize what is there, one formalizes what one thinks is happening

project were attentive and willing to learn, they declared, but as soon as the emissaries left to return to their countries, everything went back to the way it had been before, as if all that had been learned had been forgotten. The question that the OAS presented us was "What do we have to do so that the peasants may accept that what we offer them is indeed something that they can use?" We thought that we had something to contribute about the nature of knowledge that might be relevant to this situation. Hence we proposed a project that consisted of a series of seminars based on the course I had been teaching in the Faculty of Sciences of the University of Chile since 1974. They accepted our proposal, and we gave this course, with Francisco and I presenting five sections each that eventually became the ten chapters of the book that we published under the name *The Tree of Knowledge*. We allocated the chapters so that so that each of us wrote five. This was a very interesting period. The students in general, and in the laboratory in particular, were much inspired by Francisco, and some of them became his close collaborators. He was a very highly respected professor, acknowledged for his creativity in biology and mathematics.

However, we could not really collaborate at that time as we were thinking too differently by then. He was a man of great creative autonomy with a great ability to integrate and connect different manners of thinking, and he liked to build cognitive bridges. I like to keep things separate to understand them in their own domain, and only later make correlations between them after an encompassing reflection. Francisco liked to find conceptual bridges that would connect biology and phenomenology, Buddhism and science. I wanted to look at each of these different domains of thought looking for their fundamentals as not-intersecting domains of operational-relational coherence. Yet, we were able to respect our differences, and we respected them and stayed working together for a while.

Eventually, Francisco went to Europe in 1986 and established himself in France.

Personal reflections III: Changing the question

When I found out that both the nervous system and the autopoietic systems operate as closed systems, I realized that I had to change my basic questions about perception. My basic questions had been until then, "How do we human beings perceive the external world that surrounds and contains us; how does the nervous system operate in the perception of the external world?" That kind of question implicitly assumed that we could answer it through accepting what seemed to be an obvious fact, namely that such external world existed as something that we could know because it would tell us how it was through our interactions with it. Indeed, scientists thought that the basic question about knowledge was the implicit acceptance of the existence of some

He was a man of great creative autonomy with a great ability to integrate and connect different manners of thinking

Life and science are not about what is there, but about our responsibility for what we choose to do

kind of fundamental external "reality" as the ultimate fundament of everything. "Reality would give us information about itself." When I realized that we operated as closed, structurally determined systems, I realized that I could not go on asking the question "How is that which I distinguish?" Or "what is that?" I had to change my question to "What *do I do* when I claim that I distinguish something?" The question, "How does the nervous system operate as it distinguishes an external object in the act of perception?" as it is asked, implying an external world that can be known, is a question that cannot be answered. The question: "How am I doing what I am doing?" can always be answered. This is something we learn early in our childhood; for example, a mother asks a child: "have you noticed what you are doing?" Accepting this last question entails reformulating what one does as an ordinary person and as a scientist. And if we accept asking this kind of questions, everything changes in our human living. Life and science are not about *what is there*, but about *how do we do what*

we do when we make a distinction; life and science are about what we do in our living, and therefore they are about our responsibility for what we choose to do.

In 1982, I visited J. Z. Young, who had been my professor when I was an "invisible" student in England, and I gave him a copy of *The Tree of Knowledge*, which had just appeared. He asked me why Varela and I wanted to change everything. "We do not want, or at least I do not want, to change anything", I answered. And then I added: "But if we act following the consequences of our understanding that living beings are molecular autopoietic beings, and that cognition as a biological process has to do with what we do in our living, and also in the understanding that living beings live everything that they live as valid in the moment that they live it, even that which we would later call illusions, everything results as changed. There is really nothing new here other than our observing our observing, which is something that we do not usually do."

Fourth conversation with Francisco: Reaching transcendence

At some moment during the year 1996, Francisco visited me in Chile, and we had a long wonderful conversation that begun essentially when he asked me: "Humberto, do you think that there is some way in which we can reach that which is transcendent? Do you think that it is possible to experience the fundamental transcendental reality that sustains everything?" I said: "I think that that is not possible according to our nature as molecular autopoietic systems." He said: "I think that the answer is 'yes', and added, "it is possible to reach transcendental reality through meditation."

We were at my home, more loving and respectful of each other than years before. There he was, a great scientist with the candor and innocence of the young man that I had met and accepted as my student years ago aiming at the most important question for one's own life that one could ask. I loved him.

This is the difference between Francisco and I, and I consider it to be a fully respectable difference. Although we had been doing some things together, eventually we drifted so far apart that even though we were both apparently working under the same fundamental understanding of molecular autopoiesis, he could see things in a way totally different from me. For him, the way he developed his ideas was very fruitful. Our questions simply came to have a different orientation. Somehow Francisco conserved the trust in there being some transcendental universal reality, something that exists externally to our living and that can be known.

The intrinsic senselessness (not related to our biological existence) of the imagined possibility of having access to an ultimate externality is not a failure or limitation; it is our condition of existence. So anything that we may claim or propose to have the nature of a transcendental reality is necessarily an explanatory proposition that uses an invented transcendental notion intended to be used as a universal truth valid for all human beings. In the absence of any possibility of referring to a universal truth, all that we can say is that we human beings are the fundament that generates all the worlds that we live. We are not like gods who can create whatever they may wish, but we live what we live whether it is science, philosophy, art, cooking, religion, quantum physics or simple daily living occurring in the realization of our living as biological-cultural beings. Nowadays, quantum physics appears for many as if it constituted the most fundamental approach to the transcendental reality. But what do we find in quantum physics? We find no more or less than a domain of operational-relational coherences in the realization of our living that is different from classical physics. In quantum physics we talk about probabilities, but in doing that we implicitly accept as a fundament for what we do a background of structural coherences that we cannot evoke in another way, and without which to talk in terms of probabilities would be totally senseless and would not constitute a domain of possible computa-

tions. In other words, in the absence of such unknowable domain of regular processes in our living, we could not propose probabilities for the occurrence of the observable processes of quantum physics.

We human living beings explain our living with the coherences of our living. Science explains human living with the coherence of human daily living. Hence, if we are serious about accepting this, what we do in our daily living sooner or later becomes central. And as what we do in our daily living becomes central, our inner feelings and emotions appear visible as that which guides our living. I had not seen that until my colleague Ximena Dávila Yáñez showed this to me by showing me that human daily living is an individual happening, not a general abstract phenomenon about which one could speak in general terms. Human beings live as persons interweaving their living with the living of other persons.

Final reflections

Francisco was a great scientist: he had many collaborators and followers; but we were never able to collaborate: we had too different aims in our scientific lives. As I saw him, he was interested in understanding the personal experience of consciousness as a transcendental experience, and at the same time he wanted to find the configuration of neurobiological activities that is possible in the realization of our living.

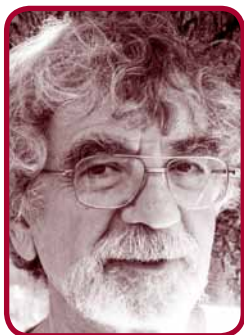
I was interested in understanding daily life and how we generate the many different worlds that we live with what we do. Ours were different paths of reflection and research, and as a consequence we never collaborated in in-depth thinking and doing things together. He was a man with great goals in life, most of which he reached. I was not – I would let things happen – and I admired his energy and determination. So, our separation was inevi-

table, sad, and in some ways frustrating, but not very traumatic.

As I have had the possibility of living a few years more than Francisco, I have had the possibility of seeing some things that I had not seen before thanks to my conversations and collaboration with my colleague Ximena. In 1999, a few years before Francisco died, Ximena said to me: “the pain and suffering for which a person consults asking for relational help is always of cultural origin.” And she added: “the person that consults me reveals in her conversation that she lived in some moment in the past a denial of love in the form of a devaluation that she unconsciously or consciously has accepted as culturally valid, and has conserved as part of her individual identity as a source of daily pain and suffering in all that she does.” As a result of that conversation, Ximena and I began a collaboration that led us to found the Matriztic Institute, now the Matriztic School of Santiago, as a center of reflection and study in the desire to understand how it is that we human beings can care for the pain and suffering of others and try to alleviate them. Ximena has also shown me something that I had not seen explicitly: namely, that we human beings live as persons. I used to speak about human beings like one speaks about butterflies, as a generality; but human beings are individual beings, persons that reflect and choose what to do or not to do as individuals. The denial of love is an action on an individual person. This was a very fundamental learning for me. Human life is indeed lived as a personal experience, and if we do not see this or invent arguments to deny it, we begin to generate pain because we stop respecting each other. Ximena Dávila and I still work together expanding our understanding of how is it that human beings care for other human beings and other living beings. Is this due to our philosophical, political or religious theories, or is it due to our biology? Our answer is that it is due to our biological history as biological-cultural beings that have conserved love as the fundamental inner feeling and emotion in their manner of living in their evolutionary natural

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HUMBERTO MATURANA ROMESÍN

Born in Chile in 1928, Humberto Maturana Romesín was interested in animals and plants from childhood and wanted to be a biologist to investigate life that dies. A long period of reflection, reading Frederic Nietzsche and Julian Huxley, occurred during three years of complete bed rest. Beginning medicine in 1950, in 1958 he received a Ph.D. in Biology from Harvard University. His main contributions in biology related to showing that living beings are molecular autopoietic systems, and that if one follows the consequences of the fact that living beings do not distinguish in their experience between perception and illusion, one can show that: language as a biological phenomenon occurs as a flow of living together in coordinations of coordinations of consensual behaviors; and cognition as a biological phenomenon occurs when an organism operates adequately to the circumstances of its living, conserving its autopoiesis as a consequence of the operational-relational coherences with its niche that are proper to it in the present of its living as a feature of the history of evolutionary structural drift to which it belongs. At least this is what he claims in the present moment.

drift. This is why that Ximena and I call our psychic-biological identity *Homo sapiens-amans amans*. Perhaps Francisco would have liked to reflect about this with us.

I have been talking about myself as a person and about Francisco as a person so that it may be apparent how different we were. Francisco was my student in the process of his becoming a scientist; we followed different paths with different aims and basic concerns in our lives, and we were already much separated in our fundamental thinking when *The Tree of Knowledge* was published. He lived a scientific life that I respected: a life of great richness and with ethical concerns as a person;

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he lived a life through which he contributed to our understanding of our humanness through his vision of consciousness. What I most admired in him was his constant desire to connect mind, body, and soul through science since the time when he was a young man that wanted to understand psychism in the universe. I wish to say that along the years I missed our early friendship and the few long conversations that we had, conversations that in their coming and going with frequent interruptions used to last many days. I do not know how he died, but I think that due to his deep Buddhist feelings it must have been a good death in the moment that it happened.

Acknowledgments

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