

# The Semiotic Body

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**Abstract** Most bodies in this world do not have brains and the minority of animal species that do have brained bodies are descendents from species with more distributed or decentralized nervous systems. Thus, bodies were here first, and only relatively late in evolution did the bodies of a few species grow supplementary organs, brains, sophisticated enough to support a psychological life. Psychological life therefore from the beginning was embedded in and served as a tool for corporeal life. This paper discusses the semiotically controlled dynamics of bodily existence that has allowed the evolution of these seemingly ‘unnatural’ mental and even linguistic kinds of species. It is shown how the skin, on the one hand, makes us belong in the world, and on the other hand, is part of the huge landscape of membranes across which the semiotic self incessantly must be reconstituted. The discussion moves on to the intracellular world of signal transduction through which the activity of single cells are put to service for bodily needs. The paper further considers the mechanisms behind homeostasis and the semiotics of the psycho-neuro-endocrine integration in the body. The concept of semiotic emergence is introduced and a holistic marker hypothesis for why some animals may have an experiential life is suggested.

**Keywords** Body · Self · Experiential life · Semiotic causation · Semiotic emergence · Holistic marker

## The Body–Corpse

The *soma–sema* opposition runs deep in western culture. The mysterious fact that people shall die or, in other words, that life disappears while the body remains, must

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have been a challenge to the metaphysical conceptions of our ancestors from the earliest of times, and the idea that a soul inhabits our body and leaves it back when we die is an obvious way to make sense of the mystery—or so we may think today. Thus, the orphics of Greek antiquity, for instance, saw the body as a tomb. In Hans Jonas' wordings: 'The body as such is the grave of the soul, and bodily death is the latter's resurrection. Life dwells like a stranger in the flesh which by its own nature—the nature of the corporeal—is nothing but corpse, seemingly alive by favor of the soul's passing presence in it' (Jonas 2001 [1966], 13). However, such a dualistic position already presupposes that life is no longer seen as an all embracing power. In the first essay of his book 'The Phenomenon of Life' Hans Jonas goes to great detail in showing that our conception of nature has undergone a 180 degrees inversion in the course of human history. Originally, life was conceived as the uncontested principle inherent to everything, and the idea of non-life was simply unimaginable (as, accordingly, was the idea of a from the body distinct entity, the soul). Now, thousands of years later, non-life or inanimate nature has come to stand as the uncontested prime ontological entity. The deepest challenge to the scientific conception of nature now comes from the undeniable fact that some objects in the world are living creatures. The French Nobel laureate and molecular biologist Jacques Monod probably more clearly than anybody else expressed the heroic ethos of modern science in his famous claim, that

'Il faut bien que l'Homme enfin se réveille de son rêve millénaire pour découvrir sa totale solitude, son étrangeté radicale. Il sait maintenant que, comme un Tsigane, il est marge de l'Univers où il doit vivre. Univers sourd à sa musique, indifférent à ses espoirs comme à ses souffrances ou à ses crimes (Monod 1970, 187–88).<sup>1</sup>

How can bodies be anything but chemistry? Isn't DNA, a purely chemical substance, the ultimate ruler of living systems? And, accordingly, is not life simply an illusion?

Only at the midpoint in this grand historical movement did we get dualism, the idea that *soma* and *sema* represents equally inescapable but incompatible dimensions (substances, properties or whatever) of our world. Intellectually, dualism was based upon a quite natural but nonetheless unsubstantiated argument: 'From the hard-won observation that there can be matter without spirit, dualism inferred that spirit can also be without matter' as Jonas put it (Jonas 2001 [1966], 16). The main problem, with this argument, is not that spirit without matter remains an unobservable and thus basically speculative entity. The main problem is that it is not obvious what the matter-spirit distinction is all about. The idea of passive matter as ruled by natural laws (or by the heavenly ruler) has long ago lost its credibility. The modern scientific world cannot easily be reduced to this far-fetched classical ideal. Instead, modern conceptions of physical nature makes ample space for the vision of the world as an emergent process in which those peculiar things we call living systems and their bodies might well have evolved as genuinely semiotic creatures.

<sup>1</sup> English translation: "If he accepts this message—accepts all it contains—then man must at last wake out of his millenary dream; and in doing so, wake to his total solitude, his fundamental isolation. Now he at last realizes that, like a gypsy, he lives on the boundary of an alien world. A world that is deaf to his music, just as indifferent to his hopes as it is to his suffering or his crimes" (Monod 1971, 172–73).

As Jonas, and before him Peirce, clearly saw, causality and teleology do not contradict each other; on the contrary, teleology is a precondition for causality to have any sense. And telos, of course, is something we know of before we know of anything else, for we know telos from our own bodies—or I shouldn't say 'our bodies': we *are* our bodies, or our bodies *are* us. If hit by something solid we get hurt, and our attempts to avoid such situations nicely brings out the interrelation of cause and telos: As Santaella-Braga expresses it paraphrasing Peirce: "Final causation without efficient causation is helpless, but efficient without final is worse than helpless...by far, it is mere chaos, and chaos is not even so much as chaos, without final causation; it is blank nothing" (CP 1. 200, (Santaella-Braga 1999, 502). Semiosis or sign action is always embedded in sensible material processes and for that reason has a dynamic side that allows the communicative process to run, as well as a complementary or mediating side. The first of these sides is governed by the compulsive force of efficient causation, the second expresses the controlling agency of *semiotic causation*, i.e., bringing about things under guidance of interpretation in a local context. Semiotic causation is a modern way of expressing the intuitions that for centuries were categorized as final causation. But since this concept has been a label for very many different positions some of which are clearly contradictory to science, I shall recommend the expression *semiotic causality* to bring out the core assumption of a biosemiotic position on the body–mind relation.

## The Skin

From birth we humans are in fact skin more than we are anything else. The skin of the newborn is, as Thure von Uexküll says, a kind of 'pre-actual atmosphere' (*vorwirkliche Atmosphäre*; Uexküll 1999), and what enters the awareness of the newborn infant is only qualities or differences between qualities, grades of intensities of touch, taste, and smell. In a certain sense, then, the newborn child's skin is a type of brain, in the sense that it is the place where encounters with the world first freeze into the vague structurings of knowledge. And, not coincidentally, the skin and the brain both originate from the same germ material, i.e., from the embryo's ectoderm layer.

Now, traditionally, most of us are taught from childhood that appearances are deceptive, and that we should not 'judge a book by its cover'—which is to say that we should not be superficial but rather go after the heart of truth that lies concealed within the surface statement. The most important and essential aspects cannot be seen or sensed directly, we are repeatedly advised, but must be dug out from their hiding places deep within the depths of things. Deepest within, goes this logic, we will find what we most profoundly feel and know.

Undoubtedly, one could argue that there are good reasons to teach children that things are not necessarily what they seem, and that the world is often full of fraud and deceit (indeed, much of philosophy after Descartes is based on this conviction). But one can also inversely argue that the belief in an innermost being, the idea of the 'true I', is for the most part a cultural bias. And here it might be useful, for a change, to try seeing the world 'from the skin's perspective.'

For the idea that personality has a place, a topological site, is not especially obvious, and by its very nature cannot be scientifically confirmed. The simple fact

that our personhood ‘presupposes’ our brain does not imply that our personhood is *in* the brain—and should we feel so compelled as to finally place our personhood in a definite biological locus, why not place it in the skin? For this is where we encounter the world around us and, in so many very obvious instances, the place where ‘all the fun’ occurs. And, in fact, the skin is an indispensable part of our personality.

Firstly, the skin is the largest and most diversified organ of the human body. If we could stretch a grown person’s skin out on the ground, it would cover between one and a half and 2 m<sup>2</sup>. This modest area is crossed by 60 km of nerve fibers and 15 km of veins and contains millions of sense receptors for pain, temperature, pressure, and touch. Incessantly, and without our knowing, the skin repairs itself after both physical and psychic traumas, and more than anything else it is the skin that tells us about the person we are, as well as about the people (and the world) that we are facing: color, form, energy, and smell provide a constant barrage of information exchange for and among humans, across the interface that is the skin.

The following description from a Norwegian physician who was afflicted with the so-called Guillan–Barrés syndrome, an illness that puts the nervous system out of commission for a time, can illuminate the skin’s predominant role in our self-understanding:

The worst experience was the disappearance and disturbance of the sense of touch. In a way, the borders of my self disappeared. When the hand was placed on the breast, it felt as if it were floating in the air. There was no ending to my breast and no beginning to my hand. *The quilt floated in the air above something that was not me.* A caress couldn’t be felt, it was only a fuzzy suggestion of something long gone. I experienced in this situation an intense feeling of being locked inside myself without possibility for physical contact with the surroundings. I saw the responses and heard the words my loved ones, but I was cut off from being physically present....This confused bodily experience was, I believe, nearly psychotic in its strangeness. The experience to be without boundaries, that thoughts and feelings were as before but the body was something different, blurred and long gone and that didn’t obey instructions, is difficult to describe. The experience of being physically cut off from physical touch and contact still remains for me an experience of hopeless loneliness (cited in Fyrand 1997, 65; my italics).

It is obvious that the skin protects us against external intrusions, but the Norwegian doctor’s account reminds us how indispensable the skin is in semiotic terms as well. *The skin keeps the world away in a physical sense but present in a psychological sense.* It is the skin that gives us the experience of belonging—it allows us to feel the world. But the very fact that the world can be felt is already a complex phenomenon that doesn’t just presuppose that there are receptors (sensory cells) in the skin that register touch, pressure, pain, cold, warmth, pH, and various chemical influences, but also that biological *meanings* are assigned to these sensations. It is not enough to sense; organisms must also create functional interpretations of the myriad of sensory stimulations so that they do not become isolated incoming impulses but are integrated into a form that the body understands and can act upon appropriately.

By way of an extremely simple example, consider a mother who sketches the number two on her child's back, and asks the child to guess the number that she just drew. The mother's light touch causes small deformations of the child's receptors (the sensory cells that lie close together just under the surface of the outer skin) and these deformations, in turn, cause a depolarization of the nerve endings. If the depolarization exceeds a certain threshold limit, an electrical impulse (i.e., an action potential) is transmitted through the nerve to the central nervous system, where a longer lasting pressure causes a series of impulses whose frequency is function of the pressure's intensity.

And already even at this level, the organism's own most current contextual situation becomes a relevant factor in the phenomenon, in that the threshold limit is defined by biochemical parameters that reflect the general condition of the organism. Thus the sense of pain, for example, is greatly influenced by so-called prostaglandins that lower the threshold values and thereby increase sensitivity. Prostaglandins are produced in connective tissue, and their production is increased in case of inflammation.<sup>2</sup>

Moreover, when these individual impulses reach the central nervous system, a system-generated integration takes place, so that the impulses from a given nerve ending are compared with impulses from nearby points in the skin (a comparison which constitutes the 'discriminative' sense) as well as with impulses from muscles and joints (constituting the so-called kinesthetic sense). The meaningful integration of these sense-data constitutes the *stereognostic sense*, and it is this sense that the child in our 'simple' example must mobilize to solve the problem—that is, to determine that the mother's drawing is representative of the number two.

As most parents know, it is not easy for a child to solve this puzzle (for reasons having almost nothing to do with numerical knowledge), and the ability to gain skill in this 'game' is in large part dependent on deliberate training. Furthermore, the kinesthetic sense is one that must be developed throughout life—it is, for example, highly developed among dancers and football players.

Most importantly, in the job of determining the number two sketched on the back, it is for the most part *the tactile sense in the skin itself* that is trained, and the task of linking these tactile signals with signals from other the sense organs is quite negligible. But in more ordinary situations, it is necessary to integrate the stereognostic sense with *all* the remaining senses to create an optimal picture of what is taking place. This involves a long chain of interpretations, or interpretants, on steadily more and more integrated levels.

## The Self

The semiotics of the skin encompasses numerous other elements beyond those associated with the senses of feeling and pain. Generally, the skin might be considered a user interface that couples us to the outer world. On one hand, the skin thus serves us as a kind of topological boundary; while, on the other hand, its semiotic capacity opens up the world to us—so that the question of where our 'self' begins and ends is not at all an easy question to answer scientifically. Are not the

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<sup>2</sup> Such production can be counteracted with acetylsalicylic acid (which is the active ingredient in ordinary pain-relief medicine).

impulses generated by the blind man's stick really a part of his 'self'? Similarly, as I can just now can 'see' houses more than four kilometers away on the other side of the fjord, it seems as if a part of myself reaches out over such a large area. And if, for example, a lightning bolt strikes on the other side, 'I' will see it in an instant, even before 'I' hear the thunderclap. 'I' exists, so to speak, in places over there.<sup>3</sup>

The problem here, of course, is that we lack a clear understanding of what our 'self' really is. Does 'the self' have a mass or dimension, or is it a purely mental entity? And do 'purely mental' entities *exist*? In the biosemiotic analysis, the problem of the self is closely associated with the problem of biological 'reference.' The skin has both an inner side and an outer side and an asymmetry is therefore established by the skin between that which is inside and that which is outside. The 'self' exists only in so far as that which is inside contains an intentionality toward, or reference to, that which is outside—an *aboutness*, as it is often called. But this outward reference rests upon a corresponding inward reference, such that one could say: other-reference presupposes self-reference.

The French philosopher Maurice Merleau-Ponty has expressed it this way: 'The evidence of the other is possible because I am not transparent to myself and because my subjectivity pulls its body behind it'<sup>4</sup> (Merleau-Ponty 2002 [1945], cited from Zahavi 1999).<sup>5</sup> And the key point here is precisely corporeality. For Merleau-Ponty, subjectivity is bodily, and to exist as a body is to exist neither as a pure subject nor as a pure object but rather to exist in a manner that overcomes this opposition. When I experience my self, and when I experience an other, corporeality is the common denominator; 'we are similar because my experience of both my self and of an other is "incarnated"'. And because my experience of the self is necessarily an experience of a kind of corporeality, it can not be separated from an experience of the "other"—"I am always a stranger to myself, and therefore open to others", as the Danish phenomenologist Dan Zahavi has subtly expressed it (Zahavi 1999).

Yet even if we let ourselves be inspired by the insights of phenomenology, we cannot let our curiosity be paralyzed by the conception of phenomenology as 'transcendental' and as in any way eliminative of scientific knowledge. Thus, while bearing in mind Merleau-Ponty's understanding of the 'self,' we shall therefore now pursue the semiotics of the skin that will show us this 'self' in its evolutionary ancestry—i.e., by generalizing it from the particular human 'self' we think we know so well to the 'self' as it occurs in other living organisms.

Under the skin we come upon even more cellular layers, layers that envelope tissues or organs—or, in other words, beneath the surface we encounter even more surfaces. And if we go further below these surfaces, we yet again find more surfaces, i.e., the membranes that surround single cells. Now, the number of cells in a mature human's

<sup>3</sup> Henri Bergson even said that "my self reaches all the way up to the stars" (cited in Kemp et al. 1997, 64).

<sup>4</sup> "L'évidence d'autrui est possible parce que je ne suis pas transparent pour moi-même et que ma subjectivité traîne après elle son corps".

<sup>5</sup> In Søren Kierkegaard's religious philosophy there is the following view of the self: "The human is spirit. But what is spirit? Spirit is the Self. But what is the self? The Self is a relationship that acts upon its self, or it is in the relationship by which the relationship relates itself to its self; the Self is not the relationship but the relationship that relates itself to its self" (Kierkegaard 1944, 1849).

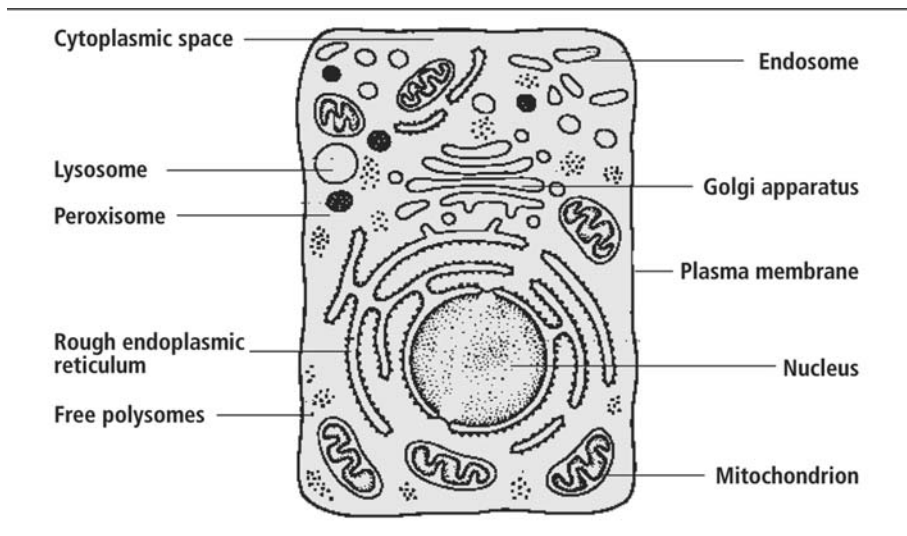
body may be estimated as 50 trillion; and if all of these cells are thought of as being spheres with an average radius of  $2.3 \times 10^{-3}$  cm, then the combined area of the cell membranes can be calculated as some 300,000 m<sup>2</sup>, or almost a third of 1 km<sup>2</sup>. Yet even this figure is probably too low—for the assumption that all the cells must be spherical is a gross idealization. The vast majority of the cells are, in fact, oblong, and thus their surface area is somewhat greater than if they were spherical in form.

Moreover, this is not yet the end of the ‘surfaces inside of surfaces’ principle in biological organization. For when we next move *into* the cell, we yet again encounter a plethora of biologically important surfaces. The cell’s interior is packed with bodies inside bodies, e.g., the so-called organelles with names such as mitochondria, lysosomes, Golgi apparatus, cell nuclei and the endoplasmic reticulum (see Fig. 1). It is difficult to estimate the cumulative area of these additional surfaces, but we would hardly exaggerate if we would say that it is tens and perhaps hundreds of times larger than the total area of the cell membranes alone. A human body, then, consists of perhaps as much as 30 km<sup>2</sup> of membrane structure. And across all of these membranes there occurs constant biosemiotic activity whereby molecular messages are exchanged in order to bring the biochemical functions on the inside and the outside of these interior membranes into concordance.

Thus, the ‘meta-membrane’ that is the human skin is indeed a highly specialized manifestation of the very same interior interface-principle whereby life processes are most generally built up.

## Signal Transduction

Cells in a multicellular organism are often very different from each other and only a very limited fraction of the genes is actually transcribed in any one of them. Early on



**Fig. 1** Schematic cross-section through eukaryotic cells with organelles (modified from Barrit 1996)

in embryogenesis almost all cells lose their totipotentiality, i.e., their potential to become whatever cell it might be. A so-called *determination* takes place, or rather a sequence of determinations, whereby the cells step-by-step become more and more specialized, so that after a certain point of time a given cell can no longer become, say, a liver cell but only a nerve cell. Sophisticated mechanisms exist to make sure that once such a determination event has occurred it will be conserved in that cell line.<sup>6</sup>

One of these mechanisms, *chromatin marking*, depends on the enzymatic modifications of chromatin, i.e. the complex of proteins and DNA whereby the DNA double helix is fixed in a more or less compact 3D superstructure. Genes that end up inside a compact superstructure are quite inaccessible to the enzyme complexes involved in transcription<sup>7</sup> and, according to current view, genes that are not supposed to be transcribed in a given cell line may perhaps be put permanently away as coiled into those compact regions of the DNA. The classic example of chromatin marking is the so-called *parental imprinting*, whereby one of the two X-chromosomes is permanently inactivated. Mammalian females are born with two copies of the X-chromosome, one descended from the father and the other from the mother, but one of them—either the father's or the mother's—is always inactivated right from the beginning by chromatin marking, and this inactivation is then passed on to the daughter cells so that in the end the X-chromosomes of all the cells in the body will be of either maternal or paternal origin.

One noteworthy consequence of this determination process, whereby different cells end up having very different protein resources at their disposal, is that different cells may interpret the same signal in very different ways. Processes responsible for the canalization of messages from the surroundings to the interior of the cell are collectively called *signal transduction*, and Luis Bruni has thoroughly analyzed the biosemiotics of signal transduction, which is probably one of the most fascinating examples of how a semiotic understanding of biochemical processes may open our eyes to the holistic-dynamical coherence of cellular life that remains rather hidden in the traditional descriptions (Bruni 2002; Bruni 2007).

Signal transduction is a remarkable process because it does not, as one might perhaps naively suspect, imply that signals from the outside somehow find their way into the cell and successively instruct the cellular machinery to initiate distinct activities. What happens is, semiotically seen, much more interesting and typically consists in the following three steps: (a) the *primary molecular signal* is received at the surface of the cell because it is recognized by a specific glycoprotein, a *receptor*, and (b) the receptor responds to the signal by changing its conformation which then activates a 'mediator-protein' in or at the cell membrane, (c) the mediator again activates a *secondary signal* at the inside of the membrane. Taken together what occurs is a kind of translation of the signal caught at the cell surface to a message formed in the intracellular molecular sign system of the cell and the process may be seen as a case of what Barbieri has called 'an organic code', here a *signal transduction code* (Barbieri 2003).

<sup>6</sup> A cell line consists of the cell and all daughter cells derived from it

<sup>7</sup> Transcription is the process whereby genes are transcribed to so-called mRNA, which is successively transported out of the nucleus to the "protein factories" in the cytoplasm (the endoplasmic reticulum) where the translation of mRNA to protein takes place



What, at the face of it, may seem surprising with this mechanism, is however that the secondary signal is normally one out of just five molecular agents (cyclic AMP, cyclic GMP, inositol triphosphate, diacyl glycerol and calcium ions). At the biochemical level it therefore looks as if an abundance at the output side—more than a hundred different primary signals are known, such as hormones, growth factors, neurotransmitters etc.—is met by a thought-provoking poverty at the receiving side. Yet, a bit of further reflection shows that this circumstance is actually the strength of the system: Because the key to the dynamics is semiotic, not chemical.

When the body is stressed and orders the adrenal medulla to secrete epinephrine, a lot of different things will occur simultaneously in different tissues. In the lung a relaxation of muscles will take place, in the liver free sugar units will be mobilized from the carbohydrate stores (glycogen), fat tissue cells will start degrading their lipid stores, and cells in the intestinal canal will react by dampening peristaltic activity. One and the same molecule thus releases a range of different activities in different kinds of cells, exactly as when the conductor of a chorus by giving just one cue with his hands gets sopranos, altos, tenors, and basses respectively to respond by four different intonations. When one and the same sign, epinephrine, can signify a range of different things to different cells, even though these cells are genetically hundred percent homogenous, its because all cells in the adult organism are descendents from embryonic cells that at some stage in development became determined for just one distinct cell destiny which also comprised a fixation of the frame for the *semiotic receptivity*, or *interpretance*, of the cell line.

For illustration let us now pursue the route taken by the signal transduction process released by epinephrine. Whether we talk about muscle cells, liver cells, fat cells, or cells of the intestinal tract the epinephrine molecule is always recognized by the same so-called beta-2-adrenergic receptors that via a mediator, a so-called G-protein, activates the formation of the secondary signal which in this case is always cAMP. In eukaryote tissues cAMP has the quite general effect of activating a protein kinase, i.e., an enzyme that activates other enzymes by attaching phosphate groups at distinct amino acid locations. And this is the level where the cellular ‘memory’, as it was fixed through the embryonic processes of determination, will make a difference. Cells in different tissues often have a very different ‘enzyme profile’, and whereas the protein kinase in liver cells causes an activation of the enzyme phosphorylase b kinase (the activity of which causes an activation of the enzyme phosphorylase, an enzyme that catalysis a cascading degradation of glycogen), then in fat tissue cells (adipocytes) the same kinase will activate the enzyme triglycerol lipase (and thereby a degradation of their lipid stores). Instead of equipping cells with sophisticated sensitivities towards multitudes of signals, evolution has chosen to provide them with an ontogenetically canalized interpretive diversity based on a diversity of subcultures, tissue-wise, each with its own characteristic receptivity.

### The Internal Surroundings

That organisms do not have just an external environment but also an internal one, or a *milieu interieur*, was the seminal idea of the French physiologist Claude Bernard (1813–1878). Bernard saw that a constant internal milieu was the very

condition for the high efficiency of complex organisms, as he expressed in the famous saying that: 'The fixity of the internal environment is the condition for free life' (Olmstead 1938, 254). In 1932 the American physiologist Walther Cannon published a famous book, 'The wisdom of the body', in which he, inspired by Bernard's ideas, introduced the term *homeostasis* [from the Greek roots for 'the same' (homeo) and 'state' (stasis)] as a designation for the surprising ability of the body to maintain a stable internal state concerning parameters such as temperature or salt balance, even under conditions of severe stress. Homeostasis depends on the coupling in certain cells between the saturation degree of specific receptors and a range of response mechanisms. If the concentration of an important component falls outside the usual range, compensative reactions, or feed backs, will be released.

Thus blood sugar in a normal person having woken up after a good night's sleep, will lie at approximately 90 mg per 100 ml. If the person now has a breakfast with plenty of sugar and cereals these compounds will successively become degraded to glucose and given off to the circulatory system and, accordingly, blood sugar will go up. The increase will be registered by sensitive cells in the pancreas and these will command the pancreas to excrete insulin to the blood. Insulin stimulates body cells to absorb glucose from the blood, and especially it stimulates liver- and muscle cells to store glucose as polysaccharide (glycogen) whereby blood sugar levels are brought back to normal. When, a couple of hours later, blood sugar is again approaching a low (due to metabolic consumption) the pancreas is once again in charge of rectifying the condition, this time by excreting the hormone glucagon that induces muscle and liver cells to degrade glycogen to free glucose. The constancy of blood sugar concentrations is thus at all times in a situation of touch and go, with insulin and glucagon as executive officers and pancreas as controlling officer. These hormonal mechanisms, however, do not operate in a vacuum but are narrowly connected to brain processes. Neurons in the area of the brain called hypothalamus are continuously monitoring blood sugar concentrations and if the level is too low, hypothalamus induces a feeling of hunger, whereas, if it is too high, a feeling of saturation will ensue.

In general, a subtle and highly complicated interplay goes on between the nervous system, in particular hypothalamus (sometimes assisted by the limbic system), and the endocrine system, i.e. the hormone producing glands, that maintains the homeostasis. Homeostasis however is far from complete, some parameters run through well controlled cyclic oscillations (as for instance coupled to the menstrual cycle), while others change in programmed ways through the phases of life or in connection to changes in conditions of life. In addition, a range of more or less programmed changes of the homeostasis are released by emotional patterns of response.

## The Psychological Body

Although most of us spend our lives as if the body was a tool for our psychological needs it takes only a moment's reflection to see that the body is the precondition for the psyche rather than vice versa. The body was there first, and only in the course of time (evolutionarily seen) did bodies develop brains sophisticated enough to support

a psychological life. It follows that the bodies must somehow have profited by the possession of a psychological life. In its most primitive versions, psychological life probably served to assure a coupling between, on the one hand, negative or positive emotions and, on the other hand, relevant patterns of action. The function of the emotional reactions must have been to establish a set of semiotic controls upon the operation of sensory-motor functions. In the course of time, these couplings have become more and more sophisticated and gradually were integrated, we may presume, into the anticipatory and memory based steering gear of the bodied brains.

In his important book of 1994, *Descartes' Error*, the American neurobiologist Antonio Damasio suggests that the cognitive and the emotional aspect of our lives have grown forth through a kind of co-evolution:

If ensuring survival of the body proper is what the brain first evolved for, then, when minded brains appeared, they began by minding the body. And to ensure body survival as effectively as possible, nature, I suggest, stumbled on a highly effective solution: representing the outside world in terms of the modifications it causes in the body proper, that is, representing the environment by modifying the primordial representations of the body proper whenever an interaction between organism and environment takes place' (Damasio 1994, 230).

This reinterpretation of neurobiology was largely based on Damasio's observations on a range of brain damaged patients, that simultaneously suffered reduced 'reasoning/decision making' and reduced 'emotion/feeling'. To his surprise Damasio found that many of these patients were unable to make rational choices, for the one and only reason that their brain damages had caused a reduction in their emotional response. Damasio concluded from these and similar studies that

the apparatus of rationality, traditionally presumed to be neocortical does not seem to work without that of biological regulation, traditionally thought to be subcortical. Nature appears to have built the apparatus of rationality not just on top of the apparatus of biological regulation, but also from it and with it.' (Damasio 1994).

And 'feelings' are as fully cognitive as any other 'perceptual image', claims Damasio,

but because of their inextricable ties to the body, they came first in development and retain a primacy that subtly pervades our mental life. Because the brain is the body's captive audience, feelings are winners among equals. And since what comes first constitutes a frame of reference for what comes after, feelings have a say on how the rest of the brain and cognition go about their business. Their influence is immense' (Damasio 1994, 128).

The distinction between emotions and feelings is central here. The emotional reactions are spontaneous, in the sense that they occur without any interference from consciousness and are released by the so-called limbic system in the subcortical region of the brain, primarily by the structure called amygdala (LeDoux 1996). What is established through the emotions are characteristic functional states of the body, or rather a kind of readiness, connected to basic survival functions such as defense against dangers, reproduction, foraging, or aggression. Emotions are released either

endogenously or as a result of inputs from the surroundings. The emotions may therefore be seen as bodily interpretants, that immediately release further interpretants in the form of characteristic kinds of behavior. The neural organization responsible for the diverse primary emotional types of behavior are rather uniform for all vertebrates (fishes, amphibians, reptiles, birds and mammals, including humans). This does not, as underlined by LeDoux, imply that the brains of all these animals are identical. But it does imply that our understanding of what a human person is as an emotional being cannot easily avoid taking into account the fact that we are so like other animals (LeDoux 1996, 17). Darwin did not doubt this:

The fact that the lower animals are excited by the same emotions—as ourselves is so well established, that it will not be necessary—to weary the reader by many details. Terror acts in the same manner on them as on us, causing the muscles to tremble, the heart to palpitate, the sphincters to be relaxed, and the hair to stand on end. Suspicion, the offspring of fear, is eminently characteristic of most wild animals (Darwin 1981 [1871]).

But while the emotional response to a high degree is the same in all vertebrate animals, feelings, in Damasio's use of language, are far more specific for humans, for feelings consist in the *experience of emotions*. The experience of fear, for instance, appears as the conscious recognition of the emotional response to a dangerous situation.<sup>8</sup> As such, feelings are much more varied and subtle than emotions, since they integrate the emotions into the rich repertoire of nuances available for conscious awareness—the danger may be imminent or more distant, it may be life-threatening or just inconvenient etc.

In human beings this leads to the formation of secondary emotions, claims Damasio, which arise 'once we begin experiencing feelings and forming systematic connections between categories of objects and situations, on the one hand, and primary emotions, on the other' (Damasio 1994, 134, italics Damasio's). The formation of these secondary emotions is no longer dependent only on the limbic system but also involves prefrontal and somatosensory brain cortexes.

The separation of the emotional response from the experienced feelings opens for a decisive insight in that it frees the understanding of the emotional response from its 'mysterious' anchoring in a conscious brain. It thus becomes possible to understand the emotional response without any need to necessarily solve the intractable soul/body problem that immediately presents itself when we talk about conscious emotional experiences. In fact, claims LeDoux, emotions, as such, are as absent from our awareness as is most of what else goes on in our brain. Biologically seen, the reason for this is simple. When an organism encounters a threat the first command is for the body to discover and react upon the danger and that, precisely, is what emotions make happen. Only next time round do we need the fear, the strongly inconvenient feeling, which can only be extinguished by confronting the threat through appropriate action.

<sup>8</sup> In this way William James' famous claim, that we do not start running because we are afraid of the bear, but, on the contrary, we are afraid of the bear because we start running, is confirmed to the extent we are talking about feelings and not—as James did—about primary emotions.

Consciousness about bodily states, feelings, therefore may be conceived as a fundamental carrier wave running through our entire psychological life, always ready to absorb and carry forward the stream of interpretations and reinterpretations that occurs in body and brain. Almost implicit in this understanding is that the emotional body states are themselves subjected to the intervention from feelings, thus giving rise, from cortical modification, to what Damasio called secondary emotions. The limbic system and the amygdala not only feed nerve impulses to the cortex but are themselves fed by impulses from the brain cortex. The secondary emotions are bodily interpretants that are continually repatterned reflecting the psychological reality that the person finds himself in, and these emotional interpretants then themselves enter into further semiotic loops of feeling based experiences in an uninterrupted chain, or network of chains, that constitute the psychosomatic reality of a human being. By far the major part of this swarming semiotic control activity remains unconscious to the person. Tacitly it takes care, moment by moment, of the necessary survival oriented integration of body and mind.

The autonomous nervous system that governs central components of the body's internal life is of course an important tool for these operations. But it has become increasingly clear that both the endocrine and the immunological system are involved in the semiotic activity by which the psychological situation of the organism feeds back into its somatic readiness potential. These connections are the theme for a new field of research in medical science that has developed strongly through the last few decades under the name of psychoneuroimmunology (PNI)—which, in spite of the name, also includes the endocrinological system as part of its subject matter.

In a pioneering work of 1975, Ader and Cohen showed that changes in the immune defense in mice might be conditioned in much the same way that dogs, in Pavlov's famous experiments from the beginning of the twentieth century, had been conditioned to salivate when hearing the sound of a bell that had previously repeatedly been rung at the time of feeding (Ader and Cohen 1975). In Ader and Cohen's experiments the compound cyclophosphamide<sup>9</sup> was injected into mice at the same time as they were fed a solution of the sweetener saccharine. Cyclophosphamide induces nausea, and it was thus not unexpected that the mice responded by developing a taste aversion against the saccharine solution. In earlier experiments Ader and Cohen had noticed that some of the thus conditioned experimental animals quite unexpectedly died upon drinking the saccharine solution (in the absence of cyclophosphamide). And since cyclophosphamide is also a strong immunodepressant, i.e., a substance that weakens the immunological response potential, Robert Ader suggested the idea that the mice were in reality dying because the saccharine solution had worked as a conditioned reflex (like the Bell in Pavlov's experiments) and had thus elicited reduced immunological readiness in the mice. This would have weakened their general resistance towards infections and some of the animals might then have succumbed to an infection.

In Ader and Cohen's experiments of 1975 this idea was basically confirmed. The intake by conditioned mice of saccharine, in the absence of any injection of

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<sup>9</sup> Cyclophosphamide has frequently been used in chemotherapy.

cyclophosphamide, evoked a significant inhibition of the immune system as measured by reduced antibody reaction in the mice toward red blood cells from sheep. The intake of the quite innocent compound saccharine was thus in the conditioned animals capable of influencing the immune system of the animals (this and many of the subsequent studies are discussed in further detail in Ader and Cohen (1993)).

A recurrent objection to the psychoimmunological interpretation of these and other experiments of the kind has been that it may not necessarily have been the taste aversion as such that conditioned a reduced immune response, instead the reduction might have been caused by the general situation of stress inflicted upon the mice. It is well-known that stress causes immunodepression, and due to the conditioning process itself the mice may have experienced the saccharine solution as a stress factor. The effect of saccharine intake on the immune system need not have been caused by cortical impulses (taste recognition), impulses from the subcortical regions (stress) may have sufficed.

It has proved extremely difficult to fully rule out this possibility as long as animal experiments are our only source for information and the corresponding experiments on human persons are for good reasons excluded. In the wake of the original experiments by Ader and Cohen, however, an almost exponential growth in PNI research has taken place and the attempts to explain away the persistent indications for psychological constituents in the endocrinological and immunological systems appears increasingly forced.

The advertising industry is in no doubt of the efficiency of conditioned reflexes in directing our choices of consumption. The stream of delicacies presented in commercials are certainly not intended for the appeal to reason, in fact, reason would be much too risky to depend on. If, however, our endocrine response is successfully stimulated, we become unconscious and more or less helpless victims to the consumptive suggestions of the ads.

## Superorganisms and Semiotic Emergence

The idea of super-organisms has a long prehistory in biology, especially in the study of social insects. Both the ant hill and the bee hive have been suggested as examples of superorganisms, with the implication that individual insects were seen as just subunits, 'mobile cells' in the superorganism. In the biological world, the delimitation of an individual is far from being always as clear-cut as it may seem in the world of vertebrate animals,<sup>10</sup> and I have no wish to take side in this quarrel.<sup>11</sup>

<sup>10</sup> An oak tree, for instance, may exhibit a symbiotic interplay between perhaps a thousand different species, and we could not, ourselves, survive in the absence of a multitude of bacterial species in the skin or the intestinal tract etc. And what about haploid individuals like many fungi and our own germ cells? Are only diploid organisms individuals?

<sup>11</sup> In my book *Signs of Meaning in the Universe* (Hoffmeyer 1996) I suggested a swarm-semiotic model of brain functions involved in creating a mental life. This proposal does of course in some sense accord ontological reality to swarm-dynamic systems of the kind we find in social insects.

From a semiotic point of view, one might perhaps suggest the criterion that, if a system's semiotic interaction with its environment presupposes a finely elaborated internal semiotic activity (a protoendosemiotics) the system deserves to be counted as an organism. Deborah Gordon's laborious and highly rewarding work with ants of the species *Pogonomyrmax barbatus*, living in a harsh zone bordering the desert between Arizona and New Mexico (Gordon 1995, 1999), has revealed a much more sophisticated pattern of semiotic interactions between individual ants than had been expected, and the survival of colonies of this species are so dependent on this protoendosemiotic regulation that the nomination of ant colonies to superorganisms feels adequate in this species. Gordon, however, does not, herself, draw this conclusion. Most remarkable in this connection she found that in ant colony behavior is not absolutely deterministic. A particularly important element in the colony's growth processes is what Gordon calls *job allocation*, and she shows that, although this task does indeed rely on a quite schematic interaction pattern between different groups of ants, an element of unpredictability persists:

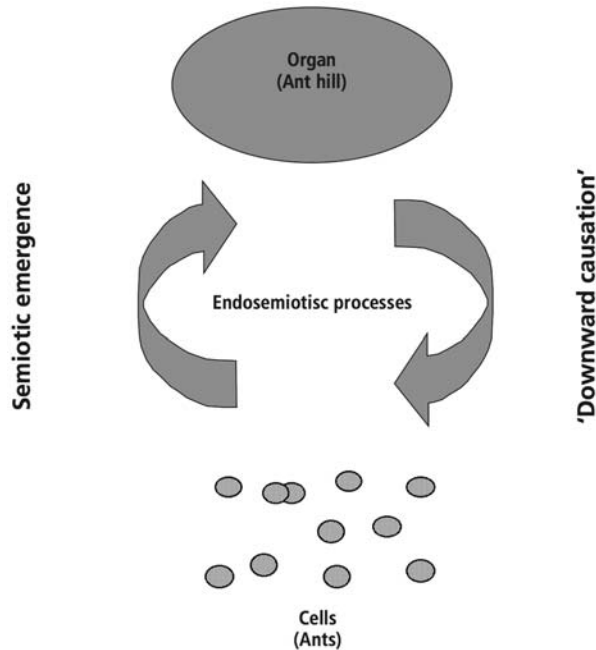
An ant does not respond the same way every time to the same stimulus; nor do colonies. Some events influence the probabilities that certain ants will perform certain tasks, and this regularity leads to predictable tendencies rather than perfectly deterministic outcomes (Gordon 1999, 139).

Gordon's experiments in this area may also be seen as a response to experiments performed by the founder of sociobiology, Edmund O. Wilson, that were claimed to show a full-blown determinism in the response pattern of ants to chemical signals (here oleic acid, Wilson 1975). Gordon's experiments, on the contrary, showed that "just as the same word can have different meanings in different situations...so the same chemical cue can elicit different responses in different social situations" (Gordon 1999, 97). Physiological, social, and ecological processes are simultaneously at work, says Gordon, and none of them are more basic than the others: "Living levels of organization is central to any study of social behavior. For humans and other social animals, an individual's behavior is always embedded in a social world" (Gordon 1999, 96).

The semiotic competence of subunits, whether these subunits are cells in a multicellular organisms or ants in an ant colony, is the medium through which the behavior and integrity of the higher-level entity is maintained. To the extent this 'endosemiotics' catches and puts to work cues or signs that indicates—are indices for—the state of the holistic unit, its 'needs', it seems justified to talk about endosemiotics and consequently the holistic system deserves to be ascribed a status as autonomous unit—a superorganism. The evolutionary formation of this kind of autonomous macro-entities is the quintessence of what is called emergence (Fig. 2). Figure 2 claims a connection between semiotic emergence (whereby macro-entities or stable large-scale patterns are established through semiotic interactions among small-scale entities) and what has been called 'downward causation' (the influence of large-scale patterns upon small-scale interactions; Bickhardt and Campbell 1999), and it is suggested that this connection is taken as constitutive for both phenomena.

The semiotic relations between subunits that collectively accounts for the stability of the large-scale or holistic system, for instance the ant hill, the multicellular organism, or perhaps the symbiotic system of bobtail squids and light-emitting vibrio

**Fig. 2** The connection between semiotic emergence and ‘downward causation’. ‘Downward causation’ operates through indexical sign relations, i.e., the values of system parameters are interpreted by lower-level agents as indexical signs. But this state of affairs in itself presupposes the formation in the first place of a large-scale pattern with a behaviour that stabilizes the semiotic interaction between parts (from Hoffmeyer 2008)



bacteria that help them,<sup>12</sup> must necessarily be geared to respond to changes in the environment in ways that do not threaten the integrity of the large-scale system. Subunits, on their part, must receive messages telling them how to uphold the macrosystem, and the easiest way to do this probably is to distribute the needs of the macrosystem via indexical signs, as we saw, for instance, in the case of *N*-acyl-homoserin lacton in the squid-vibrio symbiotic system. When night approaches the squid makes sure that the bacterial density in its mantle cavity, and thus the homoserin lacton concentration, is high enough for the bacteria to respond by allowing for the transcription of lux-operon genes, and thus for light emission to start. The point is that the semiotic emergence whereby this system was gradually established in the course of evolution necessarily also comprised the invention of semiotic means for assuring the stability of the system, and these ‘semiotic means’ are precisely what we understand by ‘downward causation’. Downward causation and semiotic emergence are thus two interwoven, but not identical, aspects of the same process. That this mechanism, based on indexical semiosis, is indeed coupled to the

<sup>12</sup> The bacteria live in the mantle cavity of the squid, and in return for food offered by the squid, the bacteria emit light of the exact same intensity and color as the light reaching the squid from the moon, and this prevents predators from seeing the squids from below (McFall-Ngai and Ruby 1998). The bacteria excrete a certain compound, *N*-acyl-homoserine, and the concentration of this compound then is an index for the density of the bacterial population in the mantle cavity of the squid. Only when the concentration of *N*-acyl-homoserine reaches above a certain threshold does the compound act to release the light performing activity of the bacteria. The key to light emission thus is the density of the bacteria, and since the squid has full control with bacterial growth (through regulation of available oxygen) the squid may switch off or on the light as it needs. A thorough treatment of the biosemiotics behind this phenomenon has been given by Luis Bruni (Bruni 2002; 2003).



circadian rhythms of the squid was confirmed by the finding that the squid has means at its disposal to fine tune light emission. It may, for instance, change the wavelength of the emitted light by help of a ‘yellow filter’ and it may weaken the intensity of light by opening a bag of ‘ink’ (Bruni 2002). Presumably the indexical sign process itself is too slow in its effect to compensate for momentary variations in background light as occurs under cloudy conditions, and evolution therefore had to provide the macrosystem (the squid) with a number of ‘additional screws’ for fine tuning.

### Self-Organization, Semiosis, and Experience

In her fine analysis of the concept of intentional behavior as a property of complex systems, the American philosopher Alicia Juarrero reminds us that the modern idea of self-organizing systems runs counter to a philosophical tradition leading back to Aristotle and that, all the way through, is based on the assumption that *causes are external to their effects* (Juarrero 1999, 2). Aristotle claimed, writes Juarrero, that nothing can move, cause, or act on itself in the same respect—and this principle has remained unchallenged throughout the history of philosophy. That a chicken develops from an egg is not, in the Aristotelian conception, due to immanent causes in the egg as a substantial thing; it is due rather to formative determinations that characterize hens in general.

Likewise, Kant inherited and expanded on this idea of causes as being external to their effects. He certainly seems to have intuited the ‘self-organizing properties’ of organisms as a characteristic trait of life, but for him this property became a reason for *not* counting life as a field for scientific understanding. As Juarrero put it:

Organisms’ purposive behavior resists explanation in terms of Newtonian mechanics and is likewise a major impediment to unifying science under one set of principles. These considerations convinced Kant that natural organisms cannot be understood according to mechanism in general or its version of causality in particular. Since only external forces can cause bodies to change, and since no ‘external forces’ are involved in the self-organization of organisms, Kant reasoned that the self-organization of nature ‘has nothing analogous to any causality known to us’. Kant thus upheld Aristotle: causes are external to their effects; self-cause, and therefore, self-organization, are phenomenally impossible (ibid. 47).

In this elegant but, as seen from the point of view of rationality, strangely powerless way, Kant escapes the obvious antinomy between a Newtonian understanding of nature and life’s self-organizing finality (see also Stjernfelt 1999).

For better or for worse, natural scientists rarely let themselves be impeded by such philosophical reflections on the permissibility or non-permissibility of this or that theoretical construction. And by the end of the twentieth century, the idea of self-organization little by little began to take hold in science, thanks to developments in a range of advanced studies in physics, biology, cognition science, economics and others. A relative consensus seems to have been reached also on the view that complex systems have dynamic properties that allow for self-organization to occur (Yarbus 1967; Haken 1984; Kauffman 1993; Kelso 1995; Port and Van Gelder

1995). Self-organization is seen here as a process by which energetically open systems of many components “tend to reach a particular state, a set of cycling states, or a small volume of their state space (attractor basins), with no external interference. This attractor behavior is often recognized at a different level of observation as the spontaneous formation of well organized structures, patterns, or behaviors, from random initial conditions (emergent behavior, order, etc.)” (Rocha 2001).

Juarrero’s book is a scientifically well-informed attempt to use the conceptual structure offered by the theory of complex adaptive systems as a resource for the establishment of a “different logic of explanation—one more suitable to all historical, contextually embedded processes, including action...” (Juarrero 1999, 5). In complex adaptive systems, there occurs such kinds of positive feedback loops whose products are themselves necessary for the process to continue and complete itself, thereby producing a ‘circular cause’ or a ‘self-cause’ (ibid). Such systems, furthermore, form dynamic wholes that are not just, as science so often assume, *epiphenomena*—but are capable, as systems, of exerting causal power over their own components, and of exhibiting both ‘formal’ as well as ‘final’ kinds of causality. Juarrero furthermore claims that causal connections between different levels in the hierarchical structure of these systems are best described as ‘constraints’—in the sense of restrictions in the space of possibilities for processes to be able to manifest or realize at any given particular level.

But Juarrero’s analyses does not at all take the semiotic aspect of selfhood into consideration. It therefore remains unexplained how the element of first person singularity (grammatically speaking) that necessarily clings to intentionality—i.e., the fact that intentionality always presupposes an intentional *subject*—might possibly have appeared out of sheer complexity. How, in other words, how could a self-organizing system that—in principle at least—might be described algorithmically in terms of sequences of ‘1’s and ‘0’s end up with intentionality in the ‘first person’ sense of this term?

Traditionally the argument has been that the reason why evolution—though based on a continuous stream of chance events—can nevertheless create strange phenomena such as people, is that we, in the words of Eugene Yates:

are the result of a random variation blocked at the statistical ‘left wall’ of simple organisms, by the fact of their minimal complexity. The thus-constrained drift through chance must be toward the right (increased complexity), but it has no special outcome or elaboration. By a concatenation of accidents encountered and avoided, we are here, along with Venus flytraps, humming birds, and crocodiles. But the *modal* (most frequent, widely distributed, and most totally massive) forms of life are the bacteria” (Yates 1998).

We concur with this argument as far as the appearance of complex organism are concerned, but, again, this kind of explanation fails to take seriously the fact that we are not just complex material aggregates, but also *subjects*. Every person is genuinely an ‘I’ phenomenon, whereas complexity in principle can be exhaustively described as an ‘it’ phenomenon. How ‘it’s’ can possibly become ‘I’s’ is the puzzle that must be explained—and not even dynamic systems theory does yet offer a solution to this puzzle. What is missing, I would argue, is the admission of a semiotic dimension of explanation.

When we are often bothered (or offended in our scientific taste) by the badly hidden anthropomorphisms in Uexküll's writings, it is because it is maintained through his whole work that animals are much more like us than science has so far been willing to accept. And this is exactly because the animals have an *Umwelt*, an internal model of the relevant parts of their environment (i.e., those parts of the environment that are relevant for them), and that this model has to be included in any fully explanatory analysis of their life.

We need to take care to express things correctly here, and it may be a problem that language simply does not readily provide us with the appropriately subtle enough words. A tick awaiting for butyric acid to reach its sense organs hardly has any 'experiences' as this term is normally understood. In fact, my guess would be that it is about as interactive as a pocket calculator in standby position. But in the moment its receptors catches the signal 'butyric acid' a reflex-like movement occurs in it, immediately causing it to drop down upon to (what turns out to be) its prey below. Now, even in this very split-second, the state of the tick does probably not rise to the level of what we might call an experience, but here one might perhaps imagine the presence of some glimpse-like state of feeling—an 'let-go' impulse of the kind that our bodies produce extra-mentally.

On one level, of course, it is pointless to discuss 'unanswerable questions' such as this. I do mention it here, however, because the question of the evolutionary history of *experiential* existence has huge theoretical implications, and raises the natural science question of: What might be the *function* of an 'experiential' world? In other words: What good is 'the having of experiences' doing in biological sense?<sup>13</sup>

We shall suggest that 'experiences' quite generally serve as a holistic markers, causing the brain machinery to focus its(our) attention upon one single track in the spatiotemporal continuity. In animals that have admittance to the world of experiences the sensory apparatus continuously processes the changing production of an astronomical number of impulses being sent to different parts of the brain that—equally continuously and in parallel—activate a number of physiological and/or motor mechanisms. All of this might presumably proceed quite efficiently in the absence of any experiential dimension—without *qualia*, as the philosophers might say. But there is a reason why a 'holistic control' must interfere, and this reason is that the organism is a *unitary* agent in its own life. Holistic control, then, is needed in order to track the finality of brain processes in accordance with an organism's ever-shifting current needs and intentions.<sup>14</sup> Thus it is through our experiences that the brain becomes a tool for the survival project of the bodily unity. As a tool for such holistic control, the body has at its disposal first its emotional equipment—as when young birds duck their heads at the sight of big-winged objects moving above

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<sup>13</sup> This of course is the essence of the famous "hard problem" of David Chalmers: Why cannot these processes go on "in the dark" and be just as effective? (Chalmers 1996).

<sup>14</sup> The bizarre finding that in Siamese twin salamanders—i.e., salamanders that have developed two independent bodies apart from a shared stomach—each head competes for food intake, although the food will end, anyway, in the shared stomach, illustrates the necessity for such a holistic marker. Such a holistic marker cannot of course be established in a such a queer system, which is the reason why this pointless competition takes place (the German embryologist and Nobel prize laureate Hans Spemann has told that the wonder he once felt toward this little creature was the reason why he was originally spurred into a lifelong carrier in embryology (mentioned in Hamburger 1988).

the nest. Such emotional reactions are accompanied by measurable alterations in the physiological and biochemical preparedness of the body.

Secondly, there must minimally be a regulatory unit that can establish a favorable correlation (or *ontogenetic optimization*) between the patterns of emotional reactions, on the one hand, and the brain's sensory-motor coordination schemes on the other. Here we are talking about a kind of correlation—or *calibration*—that is unique to the individual's life-history and cannot, for that reason, be encoded in the 'innate manual' of the genome. And this is precisely where and why 'experience' enters the picture. Experiences serve to focus brain processes according to bodily finality by the creation of an approximate isomorph or analog 'virtual reality', a single dominating 'lead track' that, as in a computer simulation, extracts an iconic representation out of its deep cerebral activity.

That experiences appear to us as analog codings of meaningful parts of our surroundings, so that we can, to some extent, justly project them out as *Umwelt*, is probably due to the fact that such codings establish the simplest possible functional mechanism. Since we are bodily creatures bound to operate by and in a world of space and time, the simplest—or safest—way to organize our calculatory imagination, also is in time and space, or in other words iconically. Our muscles are not preprogrammed to their functions, but are calibrated as such in the course of our ongoing interactive life processes, and our muscles and our experienced worlds are tightly and reciprocally calibrated. For these reasons it would not be unlikely that experiences are iconically coded in all animals that have experiences at all. The holistic control function is an emotionally anchored focusing of our brain processes. It has nothing to do with directly 'controlling' the processing of the infinite multiplicity of input that the brain receives, but only deals with establishing an overarching directional perspective. The experience is at each moment the superior, immediate, and unconditional *interpretant* in the ongoing *biosemiosis* of the organism.

Then, what about animals, whose nervous system is not sophisticated enough to produce such higher order interpretants in the form of analogically coded models? The need for some primitive version of a holistic marker is probably present in all forms of life and we imagine a graded series of such markers that in the lowest end consists in the patterns of attraction and repulsion characteristic to chemotactic behavior in bacteria. In other words, we suggest that the phenomenon of experience have primitive parallels all over the life world.

Uexküll distinguished sharply between plants and animals. Only the latter have nervous systems and therefore *Umwelts*. Plants instead possessed what he called a '*wohnhülle*'—a cover of live cells by which they select their stimuli. Like Anderson et al. (1984), we prefer to use *Umwelt* as a common concept for the phenomenal worlds of organisms, of whatever kind these might be. Although plants, fungi and protists do not possess nervous systems, they do have receptors to guide their activities, and they all, in our view, possess some kind of semiotic freedom, however limited it might be.

The experiential component of life, *qualia*, is thus seen as an integral aspect of life as such—an aspect that has had its own evolutionary history from its most primitive forms in prokaryotic life to the sophisticated kinds of *Umwelts* that we find in big-brained animals. In this respect our view is in line with the American

philosopher Maxine Sheets-Johnstone, who has sketched a ‘natural history of consciousness’ where especially proprioceptive senses play a central role for what she calls a ‘somatic consciousness’. The capacity for proprioception seems itself to have evolved, Sheets-Johnstone claims, via an internalization in the metazoans of the simple receptors that were originally localized at the surfaces of our protist ancestors (Sheets-Johnstone 1998).

Additionally, it turns out that our ‘holistic marker’ hypothesis is also in agreement with the American philosopher John Dewey, who in 1948 wrote:

The true stuff of experience is recognized to be adaptive courses of action, habits, active functions, connections of doing and undergoing; sensory-motor co-ordinations. Experience carries principles of connection and organization within itself....These principles are none the worse because they are vital and practical rather than epistemological. Some degree of organization is indispensable to even the lowest grade of life. Even an amoebae must have some continuity in time in its activity and some adaptation to its environment in space. Its life and experience cannot possibly consist in momentary, atomic, and self-enclosed sensations. Its activity has reference to its surroundings and to what goes before and what comes after. This organization intrinsic to life renders unnecessary a super-natural and super-empirical synthesis. It affords the basis and material for a positive evolution of intelligence as an organizing factor within experience” (Dewey 1948, 91).

## References

- Ader, R., & Cohen, N. (1975). Behaviorally conditioned immunosuppression. *Psychosomatic Medicine*, 37, 333–340.
- Ader, R., & Cohen, N. (1993). Psychoneuroimmunology: Conditioning and stress. *Annual Review of Psychology*, 44, 53–85.
- Anderson, M., Deely, J., et al. (1984). A semiotic perspective on the sciences: Steps toward a new paradigm. *Semiotica*, 52, 7–47.
- Barbieri, M. (2003). *The organic codes. An introduction to semantic biology*. Cambridge: Cambridge University Press.
- Barrit, G. J. (1996). *Communication within animal cells*. Oxford: Oxford University Press.
- Bickhardt, M. H., & Campbell, D. T. (1999). Emergence. In P. B. Andersen, C. Emmeche, N. O. Finnemann, & P. V. Christiansen (Eds.), *Emergence* (pp. 322–348). Aarhus: Aarhus University Press.
- Bruni, L. E. (2002). Does ‘quorum sensing’ imply a new type of biological information. *Sign Systems Studies*, 30(1), 221–243.
- Bruni, L. E. (2007). Cellular semiotics and signal transduction. In M. Barbieri (Ed.), *Introduction to biosemiotics* (pp. 365–407). Berlin: Springer.
- Chalmers, D. (1996). *The conscious mind*. Oxford: Oxford University Press.
- Damasio, A. (1994). *Descartes’ error: emotion, reason, and the human brain*. New York: Putnam Books.
- Darwin, C. (1981 [1871]). *The descent of man, and selection in relation to sex*. Princeton: Princeton University Press.
- Dewey, J. (1948). *Reconstruction in philosophy. Enlarged edition with a new forty page introduction by the author*. Boston: Beacon Press.
- Fyrand, O. (1997). *Det gådefulde sprog. Om hudens kommunikation*. København: Gyldendal.
- Gordon, D. (1999). *Ants at work. How an insect society is organized*. New York: The Free Press.
- Gordon, D. M. (1995). The development of organization in an ant colony. *American Scientist*, 83, 50–57.
- Haken, H. (1984). *The science of structure: Synergetics*. New York: Van Nostrand Reinhold.
- Hamburger, J. (1988). *The heritage of experimental embryology*. Oxford: Oxford University Press.

- Hoffmeyer, J. (1996). *Signs of meaning in the universe*. Bloomington: IN, Indiana University Press.
- Hoffmeyer, J. (2008). Biosemiotics. An examination into the signs of life and the life of signs. In John Deely (Ed.), *Approaches to postmodernity 2*. Scranton: Scranton University Press.
- Jonas, H. (2001 [1966]). *The phenomenon of life*. New York: Harper & Row.
- Juarrero, A. (1999). *Dynamics in action. Intentional behavior as a complex system*. Cambridge Massachusetts: Bradford Book.
- Kauffman, S. A. (1993). *Origins of order: Self-organization and selection in evolution*. New York: Oxford University Press.
- Kelso, J. A. S. (1995). *Dynamic patterns. The self-organization of brain and behavior*. Cambridge, MA: Bradford Book.
- Kemp, P., Lebech, M., et al. (1997). *Den Bioetiske Vending. En Grundbog i Bioetik*. København: Spektrum.
- Kierkegaard, S. (1944). *The sickness unto death*. London: Oxford University Press (first published in 1849, in Danish).
- McFall-Ngai, J., & Ruby, E. G. (1998). Sepioids and vibrios: When first they meet. *BioScience*, 48(4), 257–265.
- LeDoux, J. (1996). *The emotional brain. The mysterious underpinnings of emotional life*. New York: Simon & Schuster.
- Merleau-Ponty, M. (2002 [1945]). *Phenomenology of perception* (Colin Smith trans). London: Routledge.
- Monod, J. (1970). *Le Hazard at la Nécessité. Essai sur la Philosophie Naturelle de la Biologie Moderne*. Paris, Seuil.
- Monod, J. (1971). *Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*. New York: Knopf.
- Olmstead, J. M. D. (1938). *Claude Bernard, physiologist*. New York: Harper & Brothers.
- Port, R., & Van Gelder, T. (Eds.) (1995). *Mind as motion: Explorations in the dynamics of cognition*. Cambridge, MA: Bradford Books.
- Rocha, L. (2001). Evolution with material symbol systems. In L. M. Rocha (Ed.), *The physics and evolution of symbols and codes: Reflections on the work of Howard Pattee*. Special issue of *BioSystems* 60 (1/3):95–121.
- Santaella-Braga, L. (1999). A new causality for the understanding of the living. *Biosemiotics. Semiotica*, 127(1/4), 497–519.
- Sheets-Johnstone, M. (1998). Consciousness: A natural history. *Journal of Consciousness Studies*, 5(3), 260–294.
- Sjermfelt, F. (1999). Formal ontology. *Semiotica*, 127(1/4), 537–566.
- Von Uexküll, T. (1999). The relationship between semiotics and mechanical models. Of explanation in the life sciences. *Semiotica*, 127(1/4), 647–655.
- Wilson, E. O. (1975). *Sociobiology. The new synthesis*. Cambridge: Belknap.
- Yarbus, A. L. (1967). *Eye movements and vision*. New York: Plenum.
- Yates, E. F. (1998). Biosphere as semiosphere. *Semiotica*, 120(3/4), 439–453.
- Zahavi, D. (1999). *Self-awareness and alterity. A phenomenological investigation*. Evanston, Illinois: Northwestern University Press.