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James Barham

On the Objectivity of the *Scala Naturae*

Abstract

Scala naturae *(ladder of nature) refers to the apparent hierarchical order of organic nature. Attempts to understand and quantify this order usually invoke the concept of "complexity". Some authors argue that the* scala naturae *is merely an artifact of human perspective having no objective existence; others seek to account for biological complexity in terms of natural selection and/or information theory. It is true that the notion of complexity is closely related to that of information; it is also true that information is always relative to the goals of an epistemic agent. However, this does not mean that complexity is inherently anthropocentric, because epistemic agents need not necessarily be human. Two fundamental questions about the scientific status of information must be asked: the* objectivity *of information, and the* meaning *of information. Regarding the former, we must distinguish "allotelic" information* about *an organism relative to the goals of a human observer from "autotelic" information* for *an organism relative to the organism's own goals. Regarding the latter, it is argued that information is an inherently normative concept, that neither cybernetics nor selection theory can naturalize normativity since they both presuppose it, and therefore a different approach is required. A dynamical model of biological functionality is sketched which rationalizes the two fundamental features of functionality, namely conation and cognition. On the basis of this model, the notion of "epistemic depth" is defined. Finally, it is shown that organisms may be ranked according to their autotelic information capacity, or "epistemic depth", thus providing an objective basis for the* scala naturae.

Key words

Biological complexity, cognition, function, information, meaning, nonlinear dynamics.

Introduction

The notion that the living world possesses a hierarchical structure, traditionally referred to as the *scala naturae* (ladder of nature), has seemed self-evident to most thinkers in the Western tradition ever since Antiquity (LOVEJOY 1936). Modern advances in scientific knowledge have for the most part reinforced this impression. If one contemplates the history of life as it is now known, and considers the novel physiological and behavioral repertoires which accompanied each of its major stages—the origin of prokaryotes, eukaryotic endosymbiosis, multicellularity, metazoan encephalization—, it is hard to deny that an increase of some sort has occurred. The biological property that is invoked in attempts to understand and quantify this phenomenon is usually referred to, for lack of a more precise term, as "complexity". In recent years, a number of authors have called this commonsense way of viewing things into question. The challenge posed by these skeptics is to give an objective account of the evolution of complexity, meaning one that does not tacitly assume the human observer as a standard of comparison.

The paper is divided into five main sections. In the first section, I consider some of the arguments that have been made in support of the claim that the *scala naturae* is only a subjective artifact of our human perspective. In the second section, I examine the shortcomings of some well-known attempts to understand biological complexity by means of information theory and the theory of natural selection. In the third section, a way of understanding information as fully objective in the ontological sense is proposed. In the fourth section, it is argued that, since semantic information is intrinsically normative, and since the selectionist and information-theoretic approaches presuppose normativity and so are unable to explain it, an entirely different approach is required. Accordingly, a model of the meaning of information based on the dynamical model of biological functionality is outlined (Barham 1996, submitted). In the last main section, this model is used as the basis for an objective metric of biological complexity (epistemic depth). In conclusion, it is noted that the concept of "epistemic depth" accords well with our intuitive sense of biological complexity, and thus lends support to the claim that the *scala naturae* is objectively real.

Is the *scala naturae* an illusion?

There are two different forms of the argument that the *scala naturae* is only a subjective artifact or construct. On the one hand, it may be viewed as the myth or ideological prop of a particular culture—in this case, the Western intellectual tradition. From this point of view, the hierarchical order of the *scala naturae* is both a mirror of, and a reinforcement for, the existing power relations in European society, i.e., the hegemony of rich white males. However, while the perceived hierarchy of nature may be (like all human concepts) a social construct in some sense, it cannot be understood as deriving from social relations peculiar to European society, since similar ideas have appeared elsewhere independently, notably in China (TU 1989). Indeed, anthropological research indicates that the fundamental biological categories underlying the *scala naturae* (e.g., "plant" vs. "animal") are extremely widespread, if not absolutely universal (ATRAN 1990). Thus, it would appear that the notion of the *scala naturae* has more in common with natural kind terms which pick out real structures which exist in the world independently of human beings, than with truly culture-bound concepts (e.g., "master" vs. "slave") whose reality lies wholly within the human social order.

On the other hand, even if universal, the *scala naturae* might still be viewed as an artifact imposed on us by a quirk of human nature itself. Like a rainbow or a mirage, the hierarchical order of the living world might be similarly perceived by most or all human beings, and still be an illusion of perspective peculiar to our species lacking any objective existence. This more moderate form of skepticism about the evolution of complexity has been voiced by a number of prominent evolutionary theorists in recent years (GOULD 1996; MCSHEA 1991; RUSE 1996). According to these critics, to say that one organism is more "complex" than another one is just to pay it a kind of compliment. All we really mean is that it is more similar to ourselves.

One of the chief pieces of evidence advanced to support this claim is the fact that prokaryotes still comprise the majority of the total biomass of the earth (GOULD 1996). Since the organic world as a whole is still mostly bacteria—so the argument goes—, the *scala naturae* is an anthropocentric illusion. But this is like saying the periodic table of the elements is an illusion because the universe is still mostly hydrogen. The fact that simple forms outweigh more complex forms in total bulk is no argument against the existence of hierarchical order. On the contrary, an inverse relation between complexity and population size is the expected pattern. Things start simple. Then, over time, a few of the simple things undergo transformations leading to more complex things. In the end, this process produces a large base of elementary forms supporting a small summit of highly-derived forms, pyramid-fashion. Empirically, this seems to be the pattern underlying both chemical and biological evolution.

Of course, that still leaves the problem of specifying the units whose increase in magnitude generates the pattern in the biological case. Only by finding such a *biological equivalent of atomic number* can we demonstrate the objective existence of the *scala naturae*. Many different proposals have in fact been made over the years—from genome size, to body size, to number of repetitive parts, to number of cell types. However, a careful recent survey of this literature (MCSHEA 1996) concludes that none of these proposals enjoys much empirical support: that is, statistical sampling of the fossil record reveals few if any trends to continuous increase in any of these properties. But these empirical studies have focused on local trends within groups of organisms (mostly metazoans) that would appear to be at more or less the same level of complexity to begin with. They have not addressed the apparent global trend that has led from one broad level of complexity to another. Just as speciation is now widely conceded to follow a pattern of rapid transitions between long-term stable states, rather than one of continuous gradual change, so too may we assume that transitions between levels of complexity have probably proceeded in a similar punctuated fashion. If that is so, then the major stages of complexification (prokaryotes–eukaryotes–multicellularity–encephalization) would be invisible on the time scales of most of these studies.

Can the apparent progression from bacterium to amoeba to flatworm to octopus really be nothing more than an illusion? Is it really plausible that the only difference between an octopus and a flatworm is that we human beings "privilege" the octopus because it is more similar to us? Common sense tells us that there is a genuine phenomenon here that demands an explanation. Many other writers, of course, share this view. In the next section, I will examine two of the most popular proposals which have been made for giving a scientific account of the evolution of complexity.

The selectionist and information-theoretic approaches

One contemporary school of thought, which is probably the mainstream position, holds both that the *scala naturae* is real and that it can be explained in conventional DARWINIAN terms. On this view, evolutionary change in degree of complexity is a random walk which can go either way, up or down. However, for reasons having to do with physics rather than biology, the first organisms were very simple. This physical constraint on the origin of life imposed a set of initial conditions which biased the stochastic process of evolution, giving it directionality. In other words, since the process started at the bottom, there was "nowhere to go but up" (GOULD 1996; see also SOBER 1995). This is a "thermodynamic" style of argument: the apparent irreversibility or temporal asymmetry of the process is explained by the low-entropy initial conditions in the sense that to begin with the process only occupies a small volume of the available phase space. This argument may be correct as far as it goes, but it begs the question of the dynamics of the particular type of physical system under investigation (in this case, organic evolution), and so has very little explanatory power. It is as if a chemist were to explain the periodic table by saying "Hydrogen had to come first, so there was nowhere to go but up". That would be true, but it would hardly furnish a satisfactory explanation of the existence of the heavier elements or their relation to one another. Similarly, it is not enough to observe that life had to start simple. Of course it did. The question is not why the irreversible "arrow" of evolution runs in the direction from simple to complex, but why there is an arrow at all, and whether the apparent stages of complexification are merely "contingent", or whether there is a deeper causal principle at work. To be sure, there are any number of DARWINIAN just-so stories that may be told to explain the various stages (BONNER 1988), but like all such explanations they are essentially *ad hoc*. A natural phenomenon as striking as the *scala naturae* cries out for a more systematic and principled explanation.

If we are to arrive at a deeper understanding of the *scala naturae*, we must first find some objective way of quantifying biological complexity. A number of proposals have been made to do this using information theory. The best-known such proposal is probably the notion of "algorithmic complexity" (CHAITIN 1990). The algorithmic complexity of an object is defined as the length in bits of the shortest computer program capable of giving a complete specification of the object. A number of refinements of this concept have also been proposed, notably the notion of "logical depth" (BENNETT 1988), which considers, not the number of bits, but the number of logical steps executed by a program in describing an object (see WACKERBAUER et al. 1994, for a review of this literature).

There are two objections to this approach, an obvious one and one that is more subtle. The obvious objection is that information-theoretic metrics of biological complexity do not measure anything specifically biological: they apply equally to inorganic and organic systems. Hence, they provide no guidance for us in the decisive first step of our problem—namely, deciding what parts of an organism we ought to take as the elementary "bits" for the purpose of measuring complexity, and hence what should count as a "complete description" of a living system. As MCSHEA has pointedly asked, "What is the length of the shortest algorithm that will generate an actual rain forest?" (1996, p. 479). If we take sub-biological units—say, atoms—as our "bits", then there is no way to distinguish an organism from an inorganic system of comparable size. If we take biological units instead—genome size or number of cells types, for example—, then we will have to justify our choice on independent biological grounds. But if we were able to identify the appropriate biological units, then we would have no need of information theory in the first place. In short, information theory is no substitute for biological understanding.

A related concept which partly answers this objection is the notion of "thermodynamic depth" (LLOYD/PAGELS 1988). Whereas logical depth is the number of steps required to execute a program describing an organism in abstract "bits", thermodynamic depth is the number of steps required to physically construct an organism over the course of evolution. This is an improvement over logical depth because it takes real biological events as its fundamental units. However, thermodynamic depth is still not biological enough to do the job. The reason is that, absent an independent means of deciding what should count as an evolutionary stage or step, the only way to measure thermodynamic depth is on an absolute time scale, in which case it reduces to evolutionary age. But it is not clear how evolutionary age ought to be measured, either. Should we compare dates of evolutionary origin (since more complex organisms must have appeared more recently)? Or should we measure overall

length of evolutionary lineages (since more complex organisms must have passed through more stages and thus have longer histories)? The first approach will not work because, while complex organisms must be of more recent origin than simpler ones, not all recently-evolved organisms are necessarily complex—after all, simple organisms are still with us and presumably still evolving in various ways. But the second approach is no good either, since, assuming a monophyletic origin for all living things, all extant organisms have lineages of equal length! Either way, we are faced with the same problem: there is no way to read thermodynamic depth directly off of the fossil record against an absolute time scale. So, in order to measure thermodynamic depth, we must first specify the kinds of evolutionary changes that are to count as stages or steps. But in order to do that, we would already have to know which organisms are simple and which ones are complex. In short, like the pure information-theoretic metrics, the hybrid thermodynamic approach also begs the question of the fundamental biological units in which biological complexity must be measured.

The objectivity of information

In addition to the obvious problem with information-theoretic approaches—namely, their failure to identify a biological equivalent of atomic number—, there is also a more subtle problem. This is the problem of the scientific status of the notion of "information" itself—specifically, whether it is an objective natural phenomenon, or only a projection of the human mind.

One might suppose that the mathematical rigor of information theory would guarantee the objectivity of its results, whatever the domain in which it might be applied. After all, the reduction of a problem to algorithmic form is a paradigm case of objective scientific knowledge. However, such confidence would be misplaced. The reason is that it trades on an equivocation in the notion of objectivity, which has two quite distinct meanings (RESCHER 1997). On the one hand, objectivity may refer to claims that are valid for any human observer, apart from individual or cultural idiosyncrasies. This is "epistemic" objectivity. On the other hand, it may indicate that a claim is valid independently of the human observer altogether, that is, even if human beings did not now exist, or never had existed. This is "ontological" objectivity.

It is true that information theory is objective in the epistemic sense, for much of the power of mathematical reasoning lies in its ability to command assent from all human beings with the requisite instruction, regardless of culture, race, or gender. However, SHANNONIAN information theory is not objective in the ontological sense. That is because information as traditionally conceived has no existence apart from the human observer for whom the information is meaningful. Information is not a thing; it is not out there in the world waiting to be measured like a chunk of matter or an energy potential. Rather, it is *we* who determine what is information and what is not by treating some of the things in the world as "signal" and other things as "noise". For this reason, as GRASSBERGER has noted, "We really cannot speak of the complexity of a pattern without reference to the observer" (1989, p. 496). Hence, information theory cannot provide an account of biological complexity that is objective in the ontological sense. This does not necessarily mean that "information" is an intrinsically subjective concept, however; it just means that in order to understand information as an ontologically–objective phenomenon, we must look beyond the boundaries of Shannonian information theory and the theory of computation.

In order to arrive at a fundamental understanding of the phenomenon of information, we need to do two things. First, we must distinguish between our status as humans—that is, as observers of other organisms—from our own status as biological organisms. Does the agency necessary to constitute a physical pattern *as* information primarily reside in human observership, or is it rather a feature of the living state as such, essentially unconnected with the existence of human beings? Call this the *objectivity question*. Second, we must ask ourselves in what such agency fundamentally consists. What is it about living things that gives them the power to interpret a pattern as information?, in what does such interpretation consist?, and how can such a power be reconciled with the rest of our picture of nature? Call this the *meaning question*.

The objectivity question is by far the easier of the two to answer. We have a huge amount of evidence attesting to the fact that, far from being a peculiarly human phenomenon, information (in some sense or other) is intimately involved in all living processes (LOEWENSTEIN 1999; MIKULECKY 1996; PATTEE 1986; YATES 1997). Accepting this thesis for the sake of argument—and bracketing for the moment the question of what this means and how it is possible—we can now make the following fundamental distinction. On the one hand, there is information *for*

an organism that is meaningful with respect to the goals of that organism itself; on the other hand, there is information *about* one organism that is meaningful with respect to the goals of a second organism (such as a human observer). For the sake of clarity, let us give these two fundamentally different conceptions of information special names. Let the first kind of information that is intrinsic to an organism's own goals be called *autotelic* information, and let the second sort of information that relates to the goals of some other organism be called *allotelic* information. While allotelic information is indeed observer-relative, autotelic information is completely independent of any outside observer's interests. In short, while information is always meaningful only relative to the interests or goals of some agent or other, that agent need not be human; hence, autotelic information is fully objective in the ontological sense.

The meaning of information

With the distinction between autotelic and allotelic information in hand, let us now turn to the second, harder question—the meaning question. In what, precisely, does the meaning of information consist? The main problem here is that there is no consensus regarding the correct way to naturalize the concept of *value* (or *normativity*) which underlies the notion of "meaning". Information is meaningful (has value) insofar as it serves some purpose (aids in the accomplishment of a goal). The reason it is incoherent to use the concept "information" without reference to an agent is precisely because only living things have purposes or goals, and it is only in relation to the goal of an agent that a physical pattern can properly be said to have value or meaning. That is, nothing is "information" except insofar as it relates to the care, the concern, or the *striving* of a living thing. This is the essence of the notion of meaning: something which has instrumental value for attaining a goal. We may encapsulate this idea in the form of a maxim: *No cognition without conation*.

Now, the two main ways that philosophers have attempted to naturalize the phenomenon of goal-directed behavior are by means of cybernetic control theory (FODOR 1990), or the theory of natural selection (MILLIKAN 1993), or both (DRETSKE 1988). But do these theories explain the normativity (value) associated with purposive or goal-directed action in living systems? Do they explain conation—the power of striving? A little thought shows that they do not.

The fundamental explanatory concept of the theory of natural selection is the notion of "fitness". Fitness has been interpreted in various ways at different times, but the two basic alternatives are as follows: either fitness can be defined operationally as *actual* reproductive success (the fittest organisms are those which leave the most offspring) or else it can be defined theoretically as *potential* for reproductive success (the fittest organisms are those with traits which function better than those of their rivals). The former definition is tautological, and the latter is question-begging. That is, "survival of the survivors" is obviously not informative, while "survival of the better-functioning" is informative, but it immediately raises the question of the source of the capacity for well-functioning. The basic problem with selection theory is that it takes the prior existence of values and goals for granted; therefore, it cannot possibly explain them.

What about cybernetics? Do not the concepts of "feedback" and "control" adequately explain the existence of goal-directed phenomena in nature? They do not, and for the reason already discussed—information is itself an inherently normative concept. When we explain living processes using the machine metaphor, we forget that it is *we* who impose the boundary conditions on our machines. A thermostat does not know or care what its set-point is. If the feedback mechanisms within a machine begin to fail, or if situations unforeseen by the engineer or programmer arise, the machine will have to be readjusted or repaired by an outside agency in order for the goal-state to continue to be attained. Living things, in contrast, seek ways around obstacles and repair themselves. Machines cannot be self-repairing (in the creative or spontaneous sense) for the simple reason that stainless steel, plastic, and silicon in and of themselves do not care how they are put together. There is no ordering principle intrinsic to such materials which might give them the power to actively strive to preserve themselves in any particular configuration. Biological systems, on the other hand, *are* able to actively strive to preserve and repair themselves in their characteristic ("normal", "healthy") configurations; hence one must conclude that this power somehow derives from the nature of the biological materials themselves. As a leading biophysicist has remarked, a protein may actually be said to be "sick"—something it would be absurd to say of an individual atom (FRAUENFELDER 1987, p151). In short, the notions of information, feedback, and cybernetic control presuppose the normativity associated with a particular goal-state

of a system, and so cannot be invoked to *explain* the existence of such states, any more than selection theory can. (For further discussion of the fundamental differences between organisms and machines, see DREXLER 1989; FONTANA et al. 1995; ROSEN 1993.)

If neither cybernetics nor the theory of natural selection can naturalize normativity, then how are we to proceed towards a scientific understanding of the meaning of information? I have argued elsewhere that the only way to give a naturalistic account of the value, purpose, and meaning which are intrinsic features of all living things is to reconceptualize the living state using the conceptual apparatus of nonlinear dynamics (see BARHAM 1996, submitted, and the references therein). On this view, living things are viewed as congeries of hierarchically- and heterarchically-nested nonlinear oscillators. Each such oscillator corresponds to what we ordinarily think of as a "biological function". On this view, biofunctions are objectively real (not a human projection), and their teleological and normative character is no illusion; rather, a biological function is a real phenomenon on an ontological par with rigidity, superconducitivity, or any other emergent property of condensed matter. The precise nature of the organization of matter capable of giving rise to such phenomena is, of course, an open question (although it may be presumed to be closely connected with the immense size of biological polymers, especially proteins, which gives rise to unusual properties which elude explanation via ordinary statistical–mechanical means—FRAUENFELDER 1988; FRAUENFELDER/WOLYNES 1994; FRAUENFELDER et al. 1991). A full explanation of the unique behavior of the living state in general, and proteins in particular, will undoubtedly require insights from both nonlinear dynamics (BADII/POLITI 1997; BAK 1994, 1996; FONTANA/BUSS 1996; KAUFFMAN 1993, 1994, 1995a, 1995b; KELSO/HAKEN 1995; MIKULECKY 1993, 1996; YATES 1987, 1993, 1994) and condensed-matter physics (ANDERSON 1994; CARERI 1984; FRÖHLICH 1988; HO 1993, 1994; HO et al. 1994; JI 1991; MATSUNO 1989; MISHRA 1990; MISHRA et al. 1994; WELCH 1992), and may well involve physical principles which have yet to be discovered (for some tentative suggestions, see CONRAD 1989; DEL GIUDICE et al. 1989; MILLER 1991; PREPARATA 1995; PRIGOGINE 1997).

The idea that the unique behavior of biological systems derives directly from the unique forms of matter of which they are composed is certainly a contentious one which flies in the face of the conventional wisdom of both cybernetics and selection theory. These systems of thought maintain that the relationship between form and function is arbitrary, and that life and cognition may be "instantiated" in any physical "substrate", so long as the functional "organization" is correct. Therefore, the alternative viewpoint proposed here—that the relationship between form and function is not arbitrary at all, but is rather essential—entails a revolution in our entire worldview, which has long been based on a commitment to philosophical mechanism. But, as we have seen, the reigning doctrines are powerless to explain what it is about a certain type of organization which makes it "correct" (i.e., which gives it value), since the very idea of correctness is foreign to mechanistic science. It seems, then, that the only way out of the paradoxical situation we find ourselves in is to *relax the identification of physical causation with mechanistic interaction*. From the point of view advocated here (which may be called *biofunctional realism*—see BARHAM, submitted), efficient causation cannot be the sole principle generating order in nature. Along with a number of other authors (CASTI/KARLQVIST 1989; ROSEN 1991, 1996; THOM 1990; WEBSTER/GOODWIN 1996), I am convinced that there must be a role within science for the old ARISTOTELIAN category of "final" causation (understood in an "immanent", and not a "transcendent" sense—see LENNOX 1992). There is no room here to go into all the reasons justifying this move (see BARHAM, submitted), but the manifest failure of the traditional cybernetic and selectionist forms of explanation is itself the best reason to consider a quite different, even radical, approach to the problem of naturalizing value, purpose, and meaning. Assuming the validity of this viewpoint for the sake of argument, what can be said specifically about the meaning of information?

First of all, if a biological function is thought of as a nonlinear oscillator, then we may represent various aspects of its behavior abstractly as the mathematical properties of a phase-space *attractor*. For instance, the goal-seeking behavior of biofunctions may be identified with the property of *equifinality* (the many–to–one mapping of multiple virtual initial states of the system onto a single final state) and their robustness with that of *dynamical stability* (the ability to recover from perturbations within a certain range of magnitude). To my knowledge, the idea of using these concepts to naturalize the goal-directedness of biosystems was first stated explicitly by DELATTRE (1986). On this view, then, the *success* of a functional action construed as the cycling of a

nonlinear oscillator may be equated with the *preservation of the dynamical stability of the associated phase-space attractor*. By adopting the vocabulary of nonlinear dynamics in this way, we free ourselves from enslavement to mechanistic causation (the linear, or one–to–one, mapping of initial states onto final states). In so doing, we also obtain a powerful heuristic for giving a more adequate scientific account of biological functionality. All of this is merely the first step, however, since many inorganic nonlinear oscillators are known to exist (hurricanes, candle flames, Bénard cells, etc.). So, something else in addition to equifinality and dynamical stability must be required in order to cross the threshold from a thermodynamically-open, nonlinear dynamical system to the living state. The extra feature, I submit, is information in the autotelic sense.

But what is information? How can that phenomenon be explained scientifically, as opposed to being postulated as an unexplained primitive? First, let us ask the question: What is the fundamental difference between an organism and a hurricane, from a physical point of view? The behavior of a hurricane can be fully explained by the ordinary laws of physics—the type of order it embodies (its equifinality and its dynamical stability) ultimately derive from the fact that within constrained open systems (given certain boundary conditions and thresholds) energy dissipates faster via the production of coherent material cycles than it would via ordinary, incoherent thermal relaxation (MOROWITZ 1979; SWENSON 1992). Inorganic nonlinear oscillators are tightly coupled thermodynamically to their surrounds, and the behavior of the combined system-surround complex can be fully explained via the ordinary laws of physics (energy minimization/entropy maximization). Living things, in contrast, are only loosely coupled to the thermodynamic flows in their immediate surrounds. Indeed, the signal feature of a living system from a physical point of view is the fact that *it is capable of acting against local thermodynamic gradients*. It can do this because it carries within it "on-board" energy supplies which it can draw upon at will in order to generate the energy required to overcome unfavorable local gradients (SWENSON 1992). Now, given these undoubted facts, we must ask the question: How does an organism "know" when environmental conditions are "favorable" to it? It would seem that, in order for the on-board energy supplies to be useful, there must be some way for the organism to "decide" when they should be used. That is, it must have the ability to discriminate between favorable and unfavorable external conditions (where "favorable" is defined as tending to preserve the dynamical stability of the oscillator). So, it seems that in order for genuinely functional or normative action to be possible, there must be a means of coordinating actions with external conditions. In short, *the possibility of normativity implies the recognition of its own conditions of satisfaction*. Or, as one might say in the form of a maxim: *no conation without cognition*. Furthermore, putting this together with our previous maxim, we may conclude that *biological functionality = conation + cognition*.

This view of biological functionality can be made more definite in the guise of the following model (for details, see BARHAM 1996, and references therein). Let us suppose as a postulate that every biofunction (conceived of as a nonlinear oscillator) contains within it a subsystem such that (1) the subsystem is capable of undergoing a physical interaction with certain low-energy exogenous constraints which are in turn highly correlated with that part of the external surround which supports the high-energy functional action of the system as a whole; and (2) the interaction of the subsystem with the low-energy constraints causes a state transition in the subsystem which in turn acts internally as a trigger for the functional action. In this way, the timing of the action of a biofunction (considered as a nonlinear oscillator) may come to be correlated with the presence of just those external conditions which permit the success of the action (where "success" is understood as the oscillator's dynamical stability's being preserved). I call the postulated subsystem the *epistemon* and the interaction it undergoes with the low-energy constraints the *epistemic interaction*. The low-energy constraints themselves constitute *information* in the autotelic sense. Now, the postulated fundamental interaction between system and surround may be further analyzed into two sets of four basic elements. First is a set of entities: (a) a system (a biofunction conceived of as a nonlinear oscillator); (b) a subsystem (the epistemon); (c) a set of low-energy exogenous constraints acting on the system (information); and (d) a set of high-energy exogenous constraints (the surround). Second is a set of processes or interactions corresponding to these four entities: (i) some physical process correlating information (c) with surround (d); (ii) the epistemic interaction between information (c) and epistemon (b), resulting in a state transition in the latter; (iii) the process such that the state transition in epistemon (b) triggers the oscillation of function (a); and (iv) the functional action itself, consisting of a high-

energy interaction between the overall system (a) and its surround (d). In this way, the information–environment correlation (i) in the world is mirrored by the epistemon-function interaction (iii) in the organism. According to this model, then, information is meaningful insofar as the epistemic interaction (ii) correlates functional action (iv) with those environmental conditions which will support it. That is to say, *the meaning of information is the prediction of successful functional action*.

Biological complexity as epistemic depth

This way of looking at biological functionality and information sheds light on many problems in epistemology and the philosophy of mind (see BARHAM, submitted). Here, however, we are concerned with its implications for the question of the objectivity of the *scala naturae*. What is the relevance of the dynamical model of functionality for this problem?

On the one hand, we have an intuitive perception of the organic world in which "complexity" seems somehow correlated with "information". On the other hand, we now have in hand a dynamical model of autotelic information which (a) is ontologically objective (independent of the existence of a human observer) and (b) shows that cognition (in the form of the "epistemic interaction") is a fundamental property of biological functionality as such. On this view, the higher form of intelligence associated with metazoan brains ("cognition" in the ordinary sense of the word) is merely a derived form of a universal property of the living state as such. This leads naturally to the conclusion that *the biological equivalent of atomic number is the unit of autotelic information,* that is, *the epistemic interaction*. The next step should now be obvious.

Organisms consist of congeries of biofunctions, from enzymes in all living things to nerve cell assemblies in metazoan brains (FREEMAN 1995). Each biofunction is an atomic epistemic agent, utilizing autotelic information about conditions in the world external to itself in an effort to correlate its actions appropriately (where "appropriately" means in such a way as to preserve its dynamical stability as a nonlinear oscillator). In one sense, epistemic interactions are *universal*, since all biofunctions whatsoever are postulated to contain epistemons; in another sense, they are quite *specific* in that there are as many different kinds of epistemic interactions as there are varieties of biofunctions, and each kind of organism will have a different set of them. So, in order to arrive at an objective definition of biological complexity, all we have to do is say that *the degree of complexity of an organism corresponds to the amount of autotelic information it uses as measured by the number of different epistemic interactions it is capable of undergoing.* That is, the degree of complexity of an organism consists in the number of different kinds of biofunctions it contains, where a kind of biofunction corresponds to a type of epistemon. Let us call this measure the *epistemic depth* of an organism.

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Conclusion

To be sure, the notion of epistemic depth is highly abstract, as are all the elements of the dynamical model of biological functionality on which it is based. The latter requires fleshing out in terms of a comprehensive physical theory of the living state relating the growth of biological complexity over the course of organic evolution to the successive symmetry breakings which have led to the growth of order over the course of cosmic evolution as a whole (see BARHAM, submitted). That is a project for the future. At present, the qualitative nature of the model does not allow of empirical evaluation. However, the notion of epistemic depth is no worse off in this respect than most of the information-theoretic metrics of biological complexity which have been advanced heretofore. And it does enjoy some advantages they lack.

First, the notion of epistemic depth derives from a comprehensive theory of biological functionality. Although little more than a promissory note at present, the dynamical approach to functionality does provide a much better foundation, at least potentially, for explaining that singular feature of the living state which both cybernetics and selection theory merely assume—namely, normativity. Second, based as it is on the realization of the deep connection between the conative and cognitive aspects of functional action, the notion of epistemic depth is a simple and natural explanation of the otherwise puzzling fact that to be more "complex" seems to mean, above all, to be more "intelligent" in the sense of being able to interact with the world in a greater variety of ways. Thus, it accords well with our intuitive sense of increasing complexity from

bacterium to amoeba to flatworm to octopus. Finally, epistemic depth has the advantage over traditional information-theoretic metrics of being based on an autotelic conception of information. It is this fact, above all, which enables us to understand the *scala naturae* as an objective phenomenon in the ontological sense.

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References

Anderson, P. W. (1994) Theoretical paradigms for the sciences of complexity. In: Anderson, P. W., A career in theoretical physics. World Scientific: Singapore, pp. 584–593.

Atran, S. (1990) Cognitive foundations of natural history. Cambridge University Press: Cambridge.

Badii, R./Politi, A. (1997) Complexity. Cambridge University Press: Cambridge.

Bak, P. (1994) Self-organized criticality: A holistic view of nature. In: Cowen, G. A./ Pines, D./Meltzer, D. (eds) Complexity. Addison-Wesley: Reading MA, pp. 477–495.

Bak, P. (1996) How nature works. Copernicus/Springer-Verlag: New York.

Barham, J. (1996) A dynamical model of the meaning of information. BioSystems 38: 235–241.

Barham, J. (submitted) Biofunctional realism and the problem of teleology.

Bennett, C. H. (1988) Dissipation, information, computational complexity and the definition of organization. In: Pines, D. (ed) Emerging syntheses in science. Addison-Wesley: Redwood City, CA, pp. 215–233.

Bonner, J. T. (1988) The evolution of complexity by means of natural selection. Princeton University Press: Princeton, NJ.

Careri, G. (1984) Order and disorder in matter. Benjamin/ Cummings: Menlo Park, CA.

Casti, J./Karlqvist, A. (eds) (1989) Newton to Aristotle. Birkhäuser: Boston.

Chaitin, G. J. (1990) Toward a mathematical definition of 'life.' In: Chaitin, G. J., Information, randomness and incompleteness, 2nd ed. World Scientific: Singapore, pp. 92–110.

Conrad, M. (1989) Physics and biology: Towards a unified model. Applied Mathematics and Computation 32: 75–102.

del Giudice, E./Doglia, S./Vitiello, G. (1989) Self-organization and symmetry breaking in living matter. In: Gruber, B./Iachello, F. (eds) Symmetries in science III. Plenum: New York, pp. 379–387.

Delattre, P. (1986) An approach to the notion of finality according to the concepts of qualitative dynamics. In: Diner, S./Fargue, D./Lochak, G. (eds) Dynamical systems: A renewal of mechanism. World Scientific: Singapore, pp. 149–154.

Dretske, F. (1988) Explaining behavior. Bradford Books/MIT Press: Cambridge, MA.

Drexler, K. E. (1989) Biological and nanomechanical systems: Contrasts in evolutionary capacity. In: Langton, C. G. (ed) Artificial Life. Addison-Wesley: Redwood City, CA, pp. 501–519.

Fodor, J. A. (1990) A theory of content and other essays. Bradford Books/MIT Press: Cambridge, MA.

Fontana, W./Buss, L. W. (1996) The barrier of objects: From dynamical systems to bounded organizations. In: Casti, J. L./Karlqvist, A. (eds) Boundaries and barriers. Addison-Wesley: Reading, MA, pp. 55–115.

Fontana, W./Wagner, G./Buss, L. W. (1995) Beyond digital naturalism. In: Langton, C. G. (ed) Artificial life: An overview. Bradford Books/MIT Press: Cambridge MA, pp. 211–227.

Frauenfelder, H. (1987) Function and dynamics of myoglobin. In: Koslow, S.H./Mandell, A.J./Shlesinger, M. F. (eds) Perspectives in biological dynamics and theoretical medicine. (Annals of the New York Academy of Sciences, vol. 504.) New York Academy of Sciences: New York, pp. 151–167.

Frauenfelder, H. (1988) Protein complexity. In: Markus, M./ Müller, S.C./Nicolis, G. (eds) From chemical to biological organization. Springer-Verlag, Berlin, pp. 177–181.

Frauenfelder, H./Wolynes, P. G. (1994) Biomolecules: Where the physics of complexity and simplicity meet. Physics Today 47(2): 58–64.

Frauenfelder, H./Chu, K./Philipp, R. (1991) Physics from proteins. In: Peliti, L. (ed) Biologically inspired physics. Plenum Press: New York, pp. 1–14.

Freeman, W. J. (1995) Societies of brains. Lawrence Erlbaum Assocs.: Hillsdale, NJ.

Fröhlich, H. (ed) (1988) Biological coherence and response to external stimuli. Springer-Verlag: Berlin.

Gould, S. J. (1996) Full house. Harmony Books, New York.

Grassberger, P. (1989) Problems in quantifying self-generated complexity. Helvetica Physica Acta 62: 489–511.

Ho, M-W. (1993) The rainbow and the worm. World Scientific: Singapore.

Ho, M.-W. (1994) What is (Schrödinger's) negentropy? In: Gnaiger, E./Gellerich, F.N./ Wyss, M. (eds) What is controlling life? (Modern Trends in BioThermoKinetics, vol. 3.) Innsbruck University Press: Innsbruck, Austria, pp. 50–61.

Ho, M.-W./Popp, F.-A./Warnke, U. (eds) (1994) Bioelectrodynamics and biocommunication. World Scientific: Singapore.

Ji, S. (ed) (1991) Molecular theories of cell life and death. Rutgers University Press: New Brunswick, NJ.

Kauffman, S. A. (1993) The origins of order. Oxford University Press: New York.

Kauffman, S. A. (1994) Whispers from Carnot: The origins of order and principles of adaptation in complex nonequilibrium systems. In: Cowen, G.A./Pines, D./Meltzer, D. (eds) Complexity. Addison-Wesley: Reading, MA, pp. 83–136.

Kauffman, S. A. (1995a) 'What is life?': Was Schrödinger right? In: Murphy, M.P./O'Neill, L.A.J. (eds) What is life? The next fifty years. Cambridge University Press: Cambridge, pp. 83–114.

Kauffman, S. A. (1995b) At home in the universe. Oxford University Press: New York.

Kelso, J. A. S./Haken, H. (1995) New laws to be expected in the organism: Synergetics of brain and behavior. In: Mur-

phy, M. P./O'Neill, L. A. J. (eds) What is life? The next fifty years. Cambridge University Press: Cambridge, pp. 137–160.

Lennox, J. G. (1992) Teleology. In: Keller, E. F./Lloyd, E. A. (eds) Keywords in evolutionary biology. Harvard University Press: Cambridge, MA, pp. 324–333.

Lloyd, S./Pagels, H. (1988) Complexity as thermodynamic depth. Annals of Physics 188: 186–213.

Loewenstein, W. R. (1999) The touchstone of life. Oxford University Press: New York.

Lovejoy, A. O. (1936) The great chain of being. Harvard University Press: Cambridge, MA.

Matsuno, K. (1989) Protobiology. CRC Press: Boca Raton, FL.

McShea, D. W. (1991) Complexity and evolution: What everybody knows. Biology and Philosophy 6: 303–324.

McShea, D. W. (1996) Metazoan complexity and evolution: Is there a trend? Evolution 50: 477–492.

Mikulecky, D. C. (1993) Applications of network thermodynamics to problems in biomedical engineering. New York University Press: New York.

Mikulecky, D. C. (1996) Complexity, communication between cells, and identifying the functional components of living systems: Some observations. Acta Biotheoretica 44: 179–208.

Miller, D. A. (1991) Useful perspectives on the relation between biological and physical descriptions of phenomena. Journal of Theoretical Biology 152: 341–355.

Millikan, R. G. (1993) White Queen psychology and other essays for Alice. Bradford Books/MIT Press: Cambridge, MA.

Mishra, R. K. (ed) (1990) Molecular and biological physics of living systems. Kluwer Academic: Dordrecht, Holland.

Mishra, R.K./Maaß, D./Zwierlein, E. (eds) (1994) On self-organization. Springer-Verlag, Berlin.

Morowitz, H. J. (1979) Energy flow in biology. Ox Bow Press: Woodbridge, CT.

Pattee, H. H. (1986) Universal principles of measurement and language functions in evolving systems. In: Casti, J. L./ Karlqvist, A. (eds) Complexity, language, and life. Springer-Verlag: Berlin, pp. 268–281.

Preparata, G. (1995) QED coherence in matter. World Scientific: Singapore.

Prigogine, I. (1997) The end of certainty. Free Press: New York.

Rescher, N. (1997) Objectivity. University of Notre Dame Press: Notre Dame, IN.

Rosen, R. (1991) Life itself. Columbia University Press: New York.

Rosen, R. (1993) Bionics revisited. In: Haken, H./Karlqvist, A./Svedin, U. (eds) The machine as metaphor and tool. Springer-Verlag: Berlin, pp. 87–100.

Rosen, R. (1996) The Schrödinger question: What is life? Fifty years later. In: Buckley, P./ Peat, F. D. (eds) Glimpsing reality. University of Toronto Press: Toronto, pp. 168–190.

Ruse, M. (1996) Monad to man. Harvard University Press: Cambridge, MA.

Sober, E. R. (1995) Progress and direction in evolution. In: Campbell, J. H./Schopf, J. W. (eds) Creative evolution?! Jones and Bartlett: Boston, pp. 19–33.

Swenson, R. (1992) Order, evolution, and natural law: Fundamental relations in complex system theory. In: Negoita, C. V. (ed) Cybernetics and applied systems. Marcel Dekker: New York, pp. 125–148.

Thom, R. (1990) Semiophysics: A sketch. Addison-Wesley: Redwood City, CA.

Tu, W.-M. (1989) The continuity of being: Chinese visions of nature. In: Callicott, J. B./ Ames, R. T. (eds) Asian traditions of thought. State University of New York Press: Albany, NY, pp. 67–78.

Wackerbauer, R./Witt, A./Atmanspacher, H./Kurths, J./Scheingraber, H. (1994) A comparative classification of complexity measures. Chaos, Solitons and Fractals 4: 133–173.

Webster, G./Goodwin, B. (1996) Form and transformation. Cambridge University Press: Cambridge.

Welch, G. R. (1992) An analogical 'field' construct in cellular biophysics: History and present status. Progress in Biophysics and Molecular Biology 57: 71–128.

Yates, F. E. (ed) (1987) Self-organizing systems. Plenum: New York.

Yates, F. E. (1993) Self-organizing systems. In: Boyd, C. A. R./ Noble, D. (eds) The logic of life. Oxford University Press: Oxford, pp. 189–218.

Yates, F. E. (1994) Order and complexity in dynamical systems: Homeodynamics as a generalized mechanics for biology. Mathematical and Computer Modelling 19: 49–74.

Yates, F. E. (1997) Microsemiosis. In: Posner, R./Robering, K./ Sebeok, T. A. (eds) Semiotics, vol. 1. Walter de Gruyter: Berlin, pp. 457–464.

Alfred K. Treml

Universality and Necessity

Kant's Ethics in the Light of Modern Evolutionary Theory

Abstract

Evolutionary ethics—unlike evolutionary cognitive theory—has up to now largely avoided KANTIAN philosophy. This paper will devote itself to this desideratum and attempt to interpret KANTIAN ethics in the light of evolutionary theory. KANT's practical philosophy will first be explained on the basis of the two categories "universality" and "necessity" (a priori moral tenets), and these will be shown to be elements of a general (ancient European) rational way of thinking. From the perspective of evolutionary theory, the call for "universality" reveals itself to be compensation for the evolutionary limitation of cooperative behavior to close social ties, and "necessity" as compensation for the evolutionary decline or loss of rigid behavioral patterns in humans. Evolutionary theory allows us to interpret both categories as being the result of adaptation deficiencies of human beings vis-à-vis their cultural environment which has increasingly mutated to a global society. Seen from this perspective, "true universality" and "strict necessity" are helpful fictions of general evolutionary reason.

Key words

KANT, evolutionary ethics, reason, practical philosophy, socio–cultural evolution, evolutionary learning processes.

In 1941/42, KONRAD LORENZ developed a brilliant but simple idea (brilliant ideas are often simple), first in a psychological journal and then in a journal of animal psychology, and contrasted this idea with KANTIAN cognitive theory. According to LORENZ, KANT's *a priori* forms of possible experience are ontogenetically innate and thus *a priori* for the individual (in other words prior to all experience); phylogenetically, however, they are the contingent result of human evolution, in other words *a posteriori* (cf. LORENZ 1941/42; 1942). Thinking is thus an organic function of our brain, and this organ is the product of a natural evolution. The fact that innate forms of possible experience actually fit the world is only an expression of a phylogenetic learning process of humans in an environment. Seen from this perspective, human understanding in its basic forms "fits" the world as does the hoof of a horse to grasslands or the tail fin of a fish to the sea. What appears to be a condition of the possibility of every experience is thus itself conditioned by experience.

Although the underlying hypothesis, namely "daß das 'Apriorische' auf stammesgeschichtlich gewordene, erbliche Differenzierungen des Zentralnervensystems beruht, die eben *gattungsmäßig* erworben sind" (LORENZ 1941/42)—in other words that the operational modes of reason are themselves the product of natural development—was in no way entirely new—it had already been mentioned by Herbert SPENCER, Ernst HAECKEL, Georg SIMMEL, Ernst MACH and Hans VAIHINGER and was also expressed by Charles DARWIN in his "Descent of Man"—it was to be a big and smashing success and founded what is now known as evolutionary cognitive theory. LORENZ had only skimmed KANT's Critique of Pure Reason,[1] but this sufficed obviously to turn a central idea from its head (rationalism) onto its feet (empiricism) in order to make it fruitful. It was then only a matter of time before this central idea was applied to ethics and it mutated "evolutionary ethics". What is surprising, however, is not so much the process of application itself—it is not exactly unusual for a fruitful idea to be applied to another field by way of analogy—but rather the fact that the foundation of evolutionary ethics did not so much as touch on KANT. Evolutionary ethics sees the standards and norms on which our behavior is based as instead being products of (biological) evolution (cf. MOHR 1987; DE WAAL 1997; VOLLMER 1988; WUKETITS 1993). It focuses on the search for

universals in human behavior and their phylogenetic roots in the animal kingdom (cf. DUGATKIN 1997, the keyword in the works of Konrad LORENZ is "moralanaloges Verhalten," cf. LORENZ 1965, pp449ff), in particular the question of what adaptation value and/or selection advantage cooperative and altruistic behavior has. In addition to (human) ethological research, the findings of sociobiological research are increasingly being used in evolutionary ethics (cf. VOGEL 1986). KANT appears to be of no, or should we say, little[2] interest here not even, as was the case with the development of evolutionary cognitive theory, as a contrast or background, against which the new theory stands out more clearly.

KANT's ethics or, to be more precise, his practical philosophy (which he painstakingly developed above all in his "Metaphysic of Morals" and his "Critique of Practical Reason") appears to resist interpretation according to evolutionary theory. It appears to be far removed from everything empirical, too abstract and too formal to be of use in any manner for an empirical perspective. While certain *a priori* categories of possible experience in his Critique of Pure Reason—such as time and space—are taken up, supplemented and subjected to an *a posteriori* transformation in evolutionary cognitive theory (cf. Riedl 1980), I am not aware of similar attempts to utilize the basic categories of his practical philosophy. In the following, I aim to show that reformulating KANTIAN ethics in the light of evolutionary theory is entirely possible and fruitful. Upon closer inspection, the apparent abyss between *a priori* ethics, on the one hand, and *a posteriori* evolutionary research, on the other, reveals itself to be little more than a shallow ditch which can easily be jumped over.

True universality and strict necessity

The central concern of this paper is not, as usual, the distinct and complex argumentation of KANTIAN ethics. The literature on this topic is as diverse as the opinions it calls forth. In this respect CRAEMER-RUEGENBERG was surely correct in saying that the "universe of discourse" of KANTIAN ethics was "böse gesagt, chaotisch" (CRAEMER-RUEGENBERG 1983, p45). Almost no element of this argumentation has remained unchallenged. The fact that there has been no agreement on whether KANTIAN ethics is sufficiently substantiated (or not) may only surprise those of us who are unaccustomed to thinking in terms of evolutionary theory. From this perspective it follows that variance increases the ability to undergo further evolution. In the pages to follow, I will limit my focus to the product of KANTIAN ethics, in other words, to that which finally emerges as the result of KANTIAN considerations. I believe that this result can be reduced to two dimensions, namely the "necessity" and "universality" of a moral claim to validity. Universality and necessity are the two pillars of KANTIAN ethics (and indeed, as we will see, of the entirety of his *a priori* philosophy), and I will attempt to show that these two principles make sense in terms of evolutionary theory or, to put it more concisely, fulfill an important function of evolutionary theory.

Both elements can be illustrated by means of what is probably the best-known element of KANTIAN ethics, the "*categorical imperative*". The very term itself makes evident a moral claim to *unconditional validity*, in other words that which we have called "necessity". The word "categorical" gives expression to the unconditionality of the command, a "Gebieten, einfach hin—ohne Voraussetzungen" (Ibid, p49). As the highest command of morality, the categorical imperative gives expression to a "should" which has unconditional validity. While a "hypothetical imperative"—by contrast—is only valid providing that certain (empirical) conditions and prerequisites are met, the categorical imperative, by being based on pure reason, calls for actions which in this respect are good—and thus moral—in themselves, in other words, actions which are valid regardless of situations, people, cultures and epochs.[3] Thus an objective, general and necessary claim to validity is put forward which is truly liberated from all conditions. This categorical impetus of absolute necessity is expressed particularly well in one of the various versions of the categorical imperative: "Handle so, als ob die Maxime deiner Handlung durch deinen Willen zum allgemeinen Naturgesetz werden sollte". This makes it clear that moral law has the character of an absolutely valid natural law in so far as the existence of things according to general laws is the formal concept of nature. Only (natural) law "führt den Begriff einer *unbedingten* und zwar objektiven und mithin allgemein gültigen *Notwendigkeit*" (KANT, MdS, p63). In KANT's writings, this categorical, absolutely necessary claim of moral validity appears in many places in various linguistic guises: "unbedingt gebietend," "schlechterdings notwendig," "apodiktisch geltend," "objektiv notwendig, " "praktisch notwending" and above all "*a priori*": "Notwendigkeit kann aber nur einer Verknüpfung beigelegt werden, sofern sie *a priori* erkannt wird, denn die Erfahrung würde von einer Verbindung nur zu erkennen geben, daß sie sei, aber

nicht, daß sie so notwendigerweise sei" (KANT, KpV, p85).

KANT clearly indicates that the categorical claim to validity of necessity concerns the "form," out of which the content "follows" or in which the content appears (cf. KANT, MdS, p63). What, however, is the content? It is the universalization postulate: "Handle so, daß die Maxime deines Willens zu einem allgemeinen Gesetze werden kann!"—simply put, "universalize!" This postulate demands an unlimited amount of obligation from all rational beings. Behavior is moral if it complies with the maxim that it must be generalizable, in other words, applicable to the same extent to all people in similar situations. What is objectively valid to the same extent for *every* rational being and not just subjectively valid for a certain person is morally good. The question one should ask himself is thus: "Kannst du wollen, daß deine Maxime ein allgemeines Gesetz werden kann?" (Ibid., p44). That which is based on reasons "die für jedes vernünftige Wesen als ein solches gültig sind" (Ibid., p59) is morally good. The premise on which a decision is based should thus be generally applicable to all rational beings.

The category of universalization is also referred to in various ways in KANT's writings: universality, rule, law, natural law, principle, *a priori*, category and humanity. If we consider the following wording of the categorical imperative, "Handle so, daß du die Menschheit sowohl in deiner Person, als in der Person eines jeden andern jederzeit zugleich als Zweck, niemals bloß als Mittel brauchest" (Ibid., p81), then it will be clear that it is first and foremost about overcoming the subjectivity of the individual in favor of "humanity" as a whole and thus about objectifying it by universalization.

Universality and necessity are, however, not only the two basic pillars of KANTIAN ethics but—and this is my thesis—are also to be found in a number of conceptions of ethics and—this is by extension my second thesis—reflect the ancient European concept of reason. All theories of practical reason from PLATO to HABERMAS, RAWLS and HÖSLE imply a claim to universal validity (cf. HÖSLE 1997; SINGER 1975; WIMMER 1980). Moral values and norms are noncontingent, transcultural and unchangeable. Whatever is good in moral terms lays claim to be good everywhere in the world and for everyone. Wherever the concept of reason comprised theoretical and practical reason as well, "goodness" and "truth" were to the same extent ennobled by a universal claim to validity. Since Socrates at the latest, the respective forms of what is considered good and what is considered true have been historically contingent. These can, and indeed must, be written in plural. The "good" and the "truth," however, are only to be found in singular.

The universalization postulate of ethics calls for transsubjectivity to be produced by generalizing premises ("maxims"!). This principle is not only to be found in KANTIAN and neo-KANTIAN ethics—from HARE and SINGER to APEL and HABERMAS (cf. WIMMER 1980)—but also in all neo-ARISTOTELIAN statements on ethics, which are often presented as contrasting with all PLATONIC and KANTIAN statements (cf. HÖFFE 1992). While the formal universalization postulate in the KANTIAN tradition calls for the unity of reason by objectifying subjective claims, the neo-ARISTOTELIAN "conservative" approach appears, at least at first glance, to have undergone a limitation in relative terms when it comes to the "usual" or to the "*ethos*" of observed customs. At a second glance, however, it can be seen that a universalizing claim is present here: if everyone were to act morally in accordance with his (cultural) custom, then this would apply everywhere to everyone. Even the relativism of contingently observed customs can be universalized noncontingently. From this perspective, conventional ethics are universal and, with respect to the relativism of customs, necessary.

From the preceding it can be seen that, when confronted with the two categories of universalization and necessity, we are dealing with the two fundamental pillars of the ancient European concept of reason. Even as early as in the writings of KANT we can recognize an affinity with the general concept of reason, in other words with that which encompasses theoretical and practical reason. He thus lays claim to the validity of the "wahren Allgemeinheit und strengen Notwendigkeit" for the general introduction to his cognitive theory in the Critique of Pure Reason: KANT described as "überaus merkwürdig" the experience of *a priori* knowledge which predates any mere experience and implies "wahre Allgemeinheit und strenge Notwendigkeit" (KANT, KrV, B 6). In addition, there is another curious wording in the general introduction to his practical philosophy; when defining the scope of his categorical imperative he does not write, as can be expected, "alle Menschen" but instead "alle Vernunftwesen". When it comes to reason, we have an experience "in der sich die Allgemeinheit und Notwendigkeit einer Gesetzmäßigkeit für unser Handeln in all ihrer Rücksichtslosigkeit manifestiert" (SOMMER 1983, p102). Reason is, one could say, when something such as a claim or a requirement is everywhere the same for everyone and

is not and should not be different: "Vernünftig ist, was immer und überall uneingeschränkt gilt" (Ibid.). In KANT's own words, the claim of reason is "jederzeit nichts als die Einstimmung (aller) freien Bürger" (cf. KANT, KrV, B 766f). When we talk about reason, we assume, in other words, that something is justified in such a way that everyone would be compelled to agree if he could consider it without reservations (cf. ANACKER 1974; TREML 1982, pp75ff). Here, "everyone" refers to the universalization principle and "compelling" to the principle of necessity. Seen in this manner, the principle of morality is at the same time the principle of reason.

If this assumption is correct, we must ask ourselves whether it can be reworded in terms of evolutionary theory. In other words, what are the advantages of such a principle of reason when it comes to selection? The fact that there must be some advantage is affirmed by the dominance of this bipartite principle of reason for over two hundred years. I agree with the trivial supposition of evolutionary theory that everything which exists has a survival function. Put more cautiously, if something does not have a survival function then it is detrimental to survival. We may safely assume that dominant phenomena and those which are passed down over a long period of time are advantageous to selection and thus useful for survival. This assumption was also made by KANT when he wrote: "Alles in der Welt is irgendwozu gut, nichts ist in ihr umsonst" (KANT, KdU, p379).

In the pages to follow, I will use evolutionary theory to arrive at an interpretation of the practical principle of reason on the basis of the two categories of universality and necessity.

Our yearning for necessity

Organisms, regardless of which type, must solve a basic problem: they must maintain their complex structure, which represents a higher form of order, of negentropy, in the midst of an agitated, ambiguous, complex and unpredictable environment. In other words, they must make probable an improbable structure of negentropy in the face of a general flow of entropy (as it is worded in the second fundamental law of thermodynamics). This means they must, among other things, absorb and utilize energy as well as save and, if necessary, pass on to their descendants information about the environment. This chief problem of survival is tackled differently by each organism. Upon closer examination, however, the way this problem is tackled can be differentiated by way of a few basic forms of adaptation by learning, in other words by apprehending, saving and applying abilities. First of all there is *learning at the phylogenetic level* of species (or, more precisely, of gene pools) by mutation and selection processes over long periods of time and with a high degree of redundancy. Higher organisms such as mammals have compensated for the disadvantage of requiring large amounts of time by developing a complex central nervous system and by inventing *learning at the ontogenetic level*. This allows such organisms to adapt to changing environmental conditions in far shorter periods of time as individuals learn from experience. In turn, we can divide ontogenetic learning into learning processes which bring about an unconscious imprinting process by primarily *associative learning*. With respect to (higher) animals, this is known as "*imprinting*," a process which is only possible in childhood and adolescence and which produces inflexible and unchangeable behavioral abilities. With respect to humans, we speak about "*socialization*," a process which also takes place primarily in childhood and adolescence and which also produces relatively fixed behavioral abilities. Wherever the enhancement of behavioral abilities is consciously planned and organized, we speak of "*education*," with this applying as a rule only to humans.

Although the concepts of (phylo)genetic learning, associative learning and education can be clearly differentiated, it is difficult in specific cases to ascertain the role each plays in behavioral modification. In this context, there is one main aspect which is important, namely the decreasing degree of irreversibility of the ability learned or, in positive terms, the increasing degree of freedom. At a genetic level, the behavioral repertoire, once learned, is inflexible and unchangeable for an individual. Imprinting is possible only for a short time in childhood after which changes cannot be made. By contrast, socialization processes in humans can be changed although they can exert a strong influence throughout one's entire life. The effects of education can be changed at any time by new educational processes. We can safely say, in other words, that freedom increases. How is this to be explained, and what is the price we humans must pay?

Let us begin with a close examination of the imprinting process in animals in order to better understand the transition to associative learning and education in human beings. Konrad LORENZ has described the phylogenetically programmed physiological mechanisms of behavior and differentiated

the forms of instinctive or imprinted movement processes in appetitive behavior and eliciting stimulus (cf. LORENZ 1978, pp85ff). The advantage of imprinting over genetic learning is obvious; learning by individual experience allows an individual to adapt to different environments. The disadvantages of this type of learning are, however, the temporal limitations of childhood and adolescence and the complete inflexibility and irreversibility of the process once imprinting has been completed (cf. LORENZ 1965, pp476ff).

As organisms with more complex central nervous systems developed, this disadvantage as well was successfully compensated for by associative learning and finally in humans by learning through education. From this perspective, human beings are "unfinished entities" as they can maintain their flexible, curious youthful phase until they grow senile. As unfinished entities, human beings can thus learn through experience their entire lives. This development presupposes not only the absence of the last, non-imprintable life phase in human beings ("neoteny") but also and above all the ability to operate the necessary information and storage processes to an increasing extent cerebrally. Only with the advent of cerebral acceleration, in other words the enlargement of brain volume in Homo sapiens sapiens was the foundation laid for an ability only observed to this extent in human beings, namely that of what is known as *time and space representation competence* (TSC). Human beings are able to imagine a fictitious space in which they can, to a certain extent, test their actions. This new type of coevolution which the TSC places at the disposal of human beings has two major benefits. First, these imagined actions have a markedly lower risk of failure. If they fail at all, then only in the imagination and only as a result of other mental images.[4] Second, humans can, with the help of media such as language and writing, "learn" of the experience of others and thus learn cumulatively (there is no need for us to repeat all the mistakes others have already made).

The benefits of this ability appear to be enormous, for in human evolution we can observe the pressure exerted by selection on the further development of this ability. Above all, ever since the problem of transferring and recording different ontogenetic learning processes was solved better and better by the development of conceptual language and writing in the cultural evolution of human beings, this evolutionary "invention" outright exploded and accelerated more and more the evolution of society. However, this selection advantage had, from the very beginning, a considerable disadvantage: the decline or weakening of prescribed, i.e. innate or "imprinted," behavioral patterns which to a certain extent occur automatically and "necessarily" in certain environmental conditions. For this reason, anthropologists speak of man as being the emancipated slave of the natural world.

It is my conviction that this singular transcendence of behavioral security rooted far back in our animal past is experienced as permanent threat and risk and that the resulting fateful insecurity must be compensated for by way of secondary, i.e. cultural, forms of security. In a world in which perhaps not everything but certainly much has become contingent, we require noncontingent compensation. In the category of *necessity* we find the yearning for security, for nothing is more secure than that which is necessary, and which can only be one way and no other. *From the perspective of evolutionary theory, the fact that the category of necessity plays such a prominent role in (KANTIAN) ethics compensates for the loss of inflexible, genetically rooted, i.e. innate, behavioral patterns.*

Ethical values and norms which claim to be necessary are functionally equivalent to all genetically inherited "imperatives of nature," in other words all innate behavioral dispositions in organisms which only require the difference between appetence and eliciting stimuli in order to call up their program with absolute security. *Innate releasing mechanisms* (IRMs) thus guarantee a solution to the problem at hand (namely, to equip organisms in ambiguous and unforeseeable environmental situations with a behavioral repertoire which increases their chances of survival) by a fixed connection between signal stimuli and reactions *qua* reflexes. It is true that stimulation is required from the environment in order for this connection to be learned, but the type of connection is genetically predetermined and necessary. The actions of our animal cousins are controlled and directed in a number of ways ranging from unconditional reflexes and the control of the movement and perception apparatus to the pattern of actions governed by drive and instinct. In their entirety, IRMs provide a sort of knowledge about conditions in the world which has proven its worth. They are, to a certain extent, "angeborene Lehrmeister" (LORENZ).

To the extent that IRMs have undergone a retrogressive development in humans, the latter have become "cosmopolitan beings," an ambivalent, two-edged development in the opinion of Konrad LORENZ: "Durch ihre eigenartige zweischneidige Wirkung gibt die Domestikation dem Menschen einerseits die konstitutive Freiheit seines Denkens und

Handelns sowie seine persistierende Weltoffenheit, beraubt ihn aber andererseits jener sicheren Einpassung in die Umwelt, die das Tier seiner starr angeborenen arteigenen Verhaltensweisen verdankt" (LORENZ 1965, p489). The inherent dangers of this development are countered by a functionally equivalent cultural phenomenon. The retrogressive IRMs are replaced by "*acquired releasing mechanisms*" (ARMs) which are taught individually in and by a certain culture via socialization processes. ARMs are commensurate to that which used to be called "*ethos,*" in other words everyday habits, customs and normality. In these terms, ethos is a sort of "second nature" (ROUSSEAU) for the individual, thus *a priori*, but for the culture it is *a posteriori*. We could also say that the ethos, as the entirety of all ARMs exerting influence in a society, comprises behavioral patterns which for the individual are noncontingent and thus necessary but which, from an observer's point of view, are contingent for the culture (as a simple cultural comparison or even cultural history quickly proves).

But in the course of cultural history even these ARMs will deteriorate once social evolution confronts us with accelerated change and increased contact with other cultures and people. In the light of foreign cultures, that which has been considered to be culturally self-evident and necessary is no longer self-evident, and suspicions about the contingency of these values are more or less inevitably raised. At this point, education is required in addition to socialization to impart behavioral skills. These are individually acquired and are no longer mechanisms which more or less automatically trigger behavior; they are abilities or competence at the disposal of the individual. For this reason, I refer to them as "acquired competence" (AC). The following overview takes the three major survival systems—species, culture and individual—and the three most important learning areas—IRMs, ARMs and AC—into consideration:

	species	culture	individual
innate releasing mechanisms	a posteriori	a priori	a priori
acquired releasing mechanisms	a posteriori	a posteriori	a priori
acquired competence	a posteriori	a posteriori	a posteriori

Table 1. Phylogenetic levels of learning

As Table 1 shows, a continual reduction in the noncontingent, predetermined and unchangeable "*a prioris*" can be seen if we begin at the IRMs and move to the ARMs and AC. While IRMs are changeable and *a priori*, in other words prior to any experience, for each human culture and each individual only in extremely long evolutionary periods, ARMs can be shown to be culturally specific products of socialization which nevertheless frequently have an *a priori* character for the individual (in the form of practices and customs). AC is contingent in all three survival systems and thus *a posteriori*. Contingency increases with the development from IRMs to ARMs and AC. This development is particularly noticeable if we consider the cultural evolution of the last 2000 years. The awareness of contingency can be seen to increase continually beginning with the highly advanced cultures of the oriental and antique worlds, continuing through the late middle ages and culminating in the second half of the 18th century with the advent of the modern age (among other things in the philosophy of KANT, cf. BALLAUF in BALLAUF/SCHALLER 1970, pp571–587). That which is frequently and rather emphatically celebrated in this context as freedom does, however, have several problematic consequences. The problem with the greatest number of consequences can be worded as follows: how should we deal with this freedom? That which had previously been answered by nature (by way of a long evolutionary process of conquest) must now be answered by man himself. In addition to the (unconsciously lived) ethos, man now also requires ethics, in other words a system of values and norms conscious and justified in and of itself. As they fulfill the function of regulating contingencies, they must in no way themselves be contingent and must therefore be termed "necessary" and also be semantically ennobled as "moral". For KANT, necessary is the opposite of coincidental, in other words, of contingent. What we are dealing with here is the "Elimination alles Zufälligen" (SOMMER 1983, p107) by recovering the noncoincidental, the necessary which is "apodictically certain". KANT is availing himself here of the strong yearning for security brought about by the evolutionary contingency of human existence. At a much later date, this yearning was described by MONOD: "Wir möchten, daß wir notwendig sind, daß unsere Existenz unvermeidbar und seit allen Zeiten beschlossen ist. Alle Religionen, fast alle Philosophien und zum Teil sogar die Wissenschaft zeugen von der unermüdlichen, heroischen Anstrengung der Menschheit, verzweifelt ihre eigene Zufälligkeit zu leugnen" (MONOD 1977, p54).

When it comes to scholarly endeavor, we encounter this yearning for necessity not only in practical philosophy but also in science and theoretical phi-

losophy. The constant search for, discovery and calculation of natural laws which, if possible, are to be reduced to one natural law—a "unified theory"—enables not only their mathematical derivation but also their experimental repetition and presupposes a necessary invariance relationship (cf. Ibid., p96). In this respect, practical philosophy is at a disadvantage, as it cannot repeat experiments to confirm its own laws. Its only recourse is to appeal to the insight afforded by reason. Since this appeal must frequently be made against the (natural, i.e. inherited) "inclination" of primarily self-interested human beings, it requires, on the one hand, a devaluation of the natural inclinations—the will must be liberated "von dem Despotismus der Begierden" (KANT, KdU, p429)—and, on the other hand, the ennoblement of the ability to avail oneself of reason by the—linguistically adroit—intelligible subject. His claim to universal insight into the necessary good is called "*duty*" in KANT's writing. The KANTIAN differentiation between "*inclination*" and "*duty*" clearly expresses the tension existing between a "morality of genes" and a "morality of society". While the "morality of genes" is expressed in an innate inclination structure, the "morality of society" is perceived only as a "duty". The KANTIAN concept of duty implies an objective compulsion, namely to act, regardless of any and all inclinations, in such a way as if the maxim of the action were universal, in other words, as if the evolution of humanity were anticipated in the actions of an individual. The frequently criticized and caricatured tendency of KANT to downplay the natural inclinations of man and to attribute more importance to moral duty[5] is understandable from this perspective: the probability of selectively limiting cooperative actions to those people closest to one is transcended and the improbability of a universal (and non-inherited) moral claim which also takes other people and strangers into consideration is made probable.[6]

The KANTIAN concept of duty has little, if anything at all, to do with our everyday concept of duty, because it has nothing to do with heteronomy or even alienation. On the contrary, the autonomous and rational "I" only achieves self-consciousness, says KANT, in the apperception of duty, albeit only as an unconditional appeal to act, as if a universal (humanity) appeared within. The wording "as if" expresses a reservation which KANT is forced to make because he bases moral law not in the empirical nature of human beings but instead in the intelligible subject. Because they always take place in the empirical world, statements about the intelligible subject, which is transcendental, must, however, be provided with the reservation "as if". The theoretical usefulness of this differentiation, despite its artificiality and fiction, was shown by KANT based on the example of the concept of freedom. The practical utility of this differentiation was later convincingly shown by Hans VAIHINGER (cf. VAIHINGER 1986). VAIHINGER even went so far as to claim that all of KANT's ethics was based on fictions (cf. Ibid., pp649, 654) since necessity (and universality) are, like freedom, mere heuristic fictions, "regulative principles" (KANT), or "constructs of the imagination" which have no counterpart in reality. They are nevertheless helpful vehicles for transporting useful social norms or, to a certain extent, "expedient errors".

It is instructive in this context that the opposite of "duty" in the writings of KANT is the concept of (natural) inclination. Inclination is the "habituelle sinnliche Begierde," the "Abhängigkeit des Begehrungsvermögens von Empfindungen" (cf. EISLER 1994, p385). At this point it becomes clear that KANT uses the categorical imperative to act *against* the natural inclinations of empirical man. Compensation for the loss of necessary behavioral patterns in human beings can no longer be anchored in places where it has just be liberated by evolution. The loss or retrogression of the majority of IRMs is irreversible for humans and can no longer be hoped for in this place. The security lost as a result must be found in another place—if not in the empirical, natural subject, then in the transcendental, intelligible subject, from which a direct, apodictic "should," an absolute moral commitment originates; in the midst of a world where everything is contingent, reference is made to an instance which itself is noncontingent. The empirically provable inclinations of human nature are contingent, dependent on many (internal and external) circumstances and are thus not suitable as unequivocal and binding regulators of action.

Generalization as compensation

Let us turn now to the second main category of KANTIAN ethics, the concept of *universality*, which also fulfills a compensatory function when seen from the perspective of evolutionary theory and which can be interpreted as a helpful and useful illusion. But how? At first glance, universality does not appear to be an evolutionary principle of social norms. In evolutionary ethics, there is widespread agreement about the fact that our innate natural inclinations to altruistic and cooperative behavior are highly selective. The precept of a "natural moral-

ity" with biogenetic origins would, according to Christian VOGEL, be as follows: "Hilf deinen Verwandten nach Maßgabe ihrer jeweiligen genealogischen Verwandtschaftnähe zu dir, jedoch im Zweifelsfalle allen weniger als dir selbt (und deinen leiblichen Kindern)" (VOGEL 1986, p473). Sociobiologists add that this kinship morality can also be extended to friends and acquaintances (reciprocal altruism) and even to strangers if, in the long-term, self-interest can be furthered ("*inclusive fitness*"). A complete extension of this morality to include all of humanity as is intended in the postulate of universality of (KANTIAN) ethics appears only to be possible, from the perspective of evolutionary ethics, *against* our natural inclinations. Whether it is at all possible remains a bone of contention amongst specialists in this field, for the fact of the matter is that evolutionary success is first and foremost due to the selective limitation of altruistic actions. Only by way of this limitation can the intergenerational survival of one's own gene pool be (directly or indirectly) promoted. Extending this morality to include all of humanity is possible, in the words of Arnold GEHLEN, "der Idee nach"[7] but whether it is possible in the real world remains to be seen.

A quick look at cultural history tells us that moral norms selectively refer to one's own (within-) group. The idea of man as a species, as humanity, first appears in the doctrine of the Cynics and developed at first slowly and normatively as a counterfactual idea (cf. COULMAS 1990). A certain role was presumably played by monotheism. The "one" transcendental God made possible such an all-inclusive idea in view of the multitude of cultures. All that was then required was the secularization of this dichotomy between the world and God in KANTIAN philosophy, and we have in the secular *Zwei-Reiche-Lehre* of KANT the one transcendental subject—with all the divine attributes such as autonomy, freedom and reason—in addition to the many empirical subjects. KANT thus presents us with a philosophical concept which was to prove extremely adaptable to a social environment which is less and less able to base its unity on biologically determined areas of intimacy (of relatives and acquaintances) and instead is increasingly mutating into a large anonymous society.

My thesis is as follows: *from the perspective of evolutionary biology, the universalization postulate of KANTIAN ethics compensates for the inability of human beings to adapt to the higher complexity of the social environment which is brought about by social evolution*. With its counterfactual claim, it demands of us that we overcome natural inclinations. In other words, the categorical imperative demands of us that we transcend the phylogenetic limitation of selflessness to ourselves, our relatives, acquaintances and friends. The call to universalize thus means that, contrary to our innate inclinations, our actions should take into consideration even those people whom we do not know and will never know. In other words, "Transzendiere deine Subjektivität" (LORENZ, cf. WIMMER 1980, p98). This theoretical concept of KANTIAN ethics has become attractive for the modern mind because, in terms of social evolution, we have mutated into a global society. This development was foreseeable even in KANT's time, although it was only anticipated as a normatively espoused counterfactual idea (cf. TREML 1996). The global society can no longer base its unity on kinship morality but instead must respond to the challenge of living in an anonymous and abstract large-scale society with a formal and abstract moral principle. The categorical imperative is such a formal, abstract moral principle and it says, at bottom: overcome your natural inclinations to limit social selflessness to friends, acquaintances and next of kin, and take into consideration unacquainted, unrelated and unknown people in an anonymous large-scale society. The fact that this universalization postulate has become the core of every sort of modern ethical thinking may depend on the rift between the innate limitation of cooperation to close interactive social ties, on the one hand, and the culturally compelled adaptation to the distant parts of society which can no longer be reached interactively. This rift must be healed, for we human beings are not naturally adapted to "humanity".

The attractiveness of the KANTIAN approach to "universalization ethics" and the affirmative response it has elicited can also be explained in terms of evolutionary theory by a further train of thought. At the close of the 18th century, KANT managed to liberate modern thinking from a divine, transcendent scaffolding. His philosophy is an attempt to shift the thinking of self-conscious man into the position previously occupied by man's mere following of external divine revelation. A theocentric philosophy is replaced by an enlightened anthropocentric philosophy. KANT avoids the theoretical detour via "*nature*" as a means of justifying modern ethics; even ROUSSEAU was forced—in view of the immense variety and heterogeneity of natural states in man—to avail himself of a fictional state of nature with which, as a theoretical construction lacking an empirical basis in the real world, fault can easily be found (cf. TREML 1999, chap. 3). KANT proposes something different, namely that the binary sche-

matization of (empirical) world and (transcendent) God is, to a certain extent, placed in man, in other words it is "anthropologized". From a logical perspective, this is nothing more than a *re-entry*, in this case the re-entry of a differentiation into one side of the differentiation. Man can only truly bear the title of master over nature once he has autonomously integrated both sides of the differentiation: as an *empirical subject*, natural man and all his evolutionary sensual inclinations, on the one hand, and, as an *intelligible subject*, the transcendent part of man with all his divine attributes (such as autonomy, freedom, absolute spontaneity, etc.), on the other hand. It is thus possible to observe the multitude of human differences (namely in an empirically observable part of man) as well as the unity of the reason-oriented divine spirit (namely in the transcendental part of man). Differentiation *qua* empirical natural being and inclusion *qua* intelligible spiritual being can now be treated as a unity of difference.

This simultaneity of differentiation and inclusion (LUHMANN), of the diffusion of movement and its reconcentration as a force (SPENCER) and of diversity and universality (KANT) reminds one of the fundamental principle of evolution, namely the differentiation between variation and selection. I assume that our concept of reason still contains the notion that something, be it an idea or an action, is only then preferable when it ensures by selection our long-term survival in the face of a multitude of possibilities (variation). The difference between teleological (spiritual) and teleonomic (evolutionary) reason would then only be that teleological reason can observe this recourse to selection in advance (*qua* "prestabilized harmony"), whereas teleonomic reason can only observe it subsequently (*qua* "poststabilized harmony). Teleological or target-oriented reason would be when all arguments freely varied—and this is what we mean by "universalization"—and we were able to imagine possible ways of acting (in other words by mental anticipation) and to succeed in selecting a variant which could be comprehensible as a (noncontingent) necessity.

The recourse to the "intelligible subject" and the related apodictic "should" of moral commitment compensate for the contingency of human volition. This necessitates their being presented as reason which is universal and necessary. In view of this reason, we have an experience "der sich die Allgemeinheit und Notwendigkeit einer Gesetzmäßigkeit für unser Handeln in all ihrer Rücksichtslosigkeit manifestiert" (SOMMER 1983, p102). This ennoblement is necessary, for only in this way can heteronomy by God or nature be transformed into self-determination. From now on, reason must be universalized necessity or necessary universalization, for the empirical "I" is bound to the body and natural and thus accidental and contingent. It is now clear why the modern concept of reason comprises the principles of necessity and universality: in theory, only by way of the necessity of *one* universal reason can the contingency of the *many* special "selves" be integrated so that the evolutionary loss of innate knowledge can be compensated for. Several "reasons" would fail to provide a clear solution to the problem of contingency and instead would only extend it on a "metalevel".

The absoluteness of the categorical imperative reflects the yearning for a solid, immovable and noncontingent foundation which we humans have lost in the history of the evolution of our species. We are only able to cope with the freedom provided by contingency if it, in turn, is bound to a universality which is necessary but not real. What remains is a counterfactual regulative idea, an as-if assumption, a practical fiction, for if it were real it would, in turn, be contingent and would lose its generally valid function of regulating contingency. As a regulative idea, the (regulative) *notion* of universality suffices, one does not require the assumption of its existence. The claim of universality to be truly universal remains a theoretically indispensable and extremely fruitful fiction because it places everything special (e.g. each action) under an "eschatological" reservation and thus protects history from experiencing a precipitous end (cf. KÜMMEL 1970).

Thus the category of universalization compensates for not only the many heterogenous subjective claims but also the dangerous claim of universality to being truly universal and ossifying in a historical void.[8] The modern concept of reason contains this idea, according to which the universal inherent in it must never really come to an end—fulfillment would be the end—because otherwise the differentiation between critical reason and dogmatic reason could no longer be made (cf. ANACKER 1974, pp1603ff). This idea (and not only this differentiation) can be found in the writings of KANT, although not in his theoretical works on the theory of cognition and ethics but in his writings on anthropology, the philosophy of history and the methodology of the teleological understanding of his criticism of understanding. The community as a whole cannot achieve ontogenetic fulfillment; the individual always remains subjective and, as a natural entity, is subject to the whims of nature; the true community

fulfills itself phylogenetically: only in humanity as a temporalized whole can man truly make himself universal. For this reason, the categorical imperative orders us to anticipate humanity in the actions of individual human beings, to anticipate "die Menschheit... in deiner Person als auch in der Person eines jeden anderen..." In the global human community, universality becomes necessary and necessity becomes universal. The moral law of the categorical imperative is and remains a pure principle of reason; it cannot be deduced as an applied principle for action. In other words, pure reason is powerless even in the form of the categorical imperative. For this reason, all actions are placed under the reservation that they may be immoral.

From the perspective of evolutionary biology, KANT is attempting with this theory to reconcile the natural moral disposition which is limited to close social ties and, in extreme cases, to modern individualism with the compulsion arising from cultural evolution of living in an anonymous mass society which can no longer maintain its unity by way of genetic or reciprocal altruism. The call to universalize compensates for the natural limitation of altruism to genetically based egoistic altruism and requires us to transcend this limitation and take the whole of humanity into consideration. This universality fulfills itself in humans as rational beings. The categorical imperative is a transsubjective principle which not only exceeds the freedom from (external) nature ("natural freedom") and the freedom from human domination ("civil freedom") but also transcends the freedom from oneself, from one's genetically and egoistically based inner nature ("sensory freedom") and thus reconciles the subjective "I" with the objective "I" *qua* universalized humanity.[9]

Summary

The findings of this analysis can be summarized as follows: KANT's ethics with its two pillars of universality and necessity compensates for specific adaptation problems encountered by a social evolution which is continually mutating towards larger and more anonymous social systems. The principle of universality is offered as a useful secondary (i.e. cultural) selection value for cooperative behavior in an untransparent social system—from the perspective of evolutionary theory, the call to universalize simply means that we must transcend our genetic fixation on close social ties, for this limitation has been made superfluous by social evolution. However, this is only a pretension, a dictate, and not a description of actual circumstances. Whether or not there actually is something such as love for strangers and enemies is a matter of debate.[10] Whether the natural limitation of our cooperative abilities to close social relations can be completely overcome appears questionable when seen from today's perspective. With the principle of necessity, (KANTIAN) moral theory responds to the high demand for security in regulating the contingencies of human action patterns. This demand for security and orientation is deeply rooted in every living thing. As it can no longer be satisfied in humans by IRMs and less and less by ARMs, philosophical (i.e. communicative) solutions are required which lay claim to well-founded security.

However, in the writings of KANT, both categories are, as has already been mentioned, categories of "pure reason" which means, among other things, that they are mere counterfactual ideas which may serve cognitive and practical orientation but can nowhere be identified in the real world with any degree of security. KANT is often criticized for his formalism and aloofness from the workings of the real world, but critics tend to overlook the fact that his limitation to pure reason is the price he is willing to pay in order to save freedom. Thus KANT is able not only to make plausible the causality of nature as a category of order but also to make conceivable a causality of freedom and thus reconcile teleological *and* teleonomic thinking with one another. According to KANT, it is inherent in nature that the freedom of reason should have full scope to develop itself. The final purpose of nature is culture. The teleonomic objective of this process (of hominid evolution) is the "völlige Entwicklung der Anlagen der Menschheit" in "weltbürgerlichen Rechtszustand" by means of the natural "gesellige Ungeselligkeit der Menschen," in other words the contradiction between our inclinations towards egoism and cooperation (cf. KLEINGELD 1995). This antagonism (which is inherent in the nature of man) leads to the cultural development of all talents and to the establishment of taste and morality. Thus, from an evolutionary perspective, KANT interprets natural history as progress, but as teleonomic and not teleological progress. As the concept of teleonomy was not at his disposal, KANT availed himself of the topos of "natural teleology," a sort of as-if teleology: in order to recognize nature, we must act as if all natural things serve one another as means to an end (cf. KANT, KdU, second part). As we are only able to reconstruct these ends *qua* objectives with hindsight, this natural teleology is that which is referred to as teleonomy in modern evolutionary science. Put paradoxically,

this is the increasingly accidental direction of evolution *ante festum* which appears necessary—as "poststabilized harmony"—*post festum*.

Thus evolutionary theory does not consider ethical maxims to be floating markings *a priori*. Instead, this analysis of KANTIAN ethics has shown that in particular the *a priori* elements of practical reason fulfill an empirically identifiable, compensatory function. The principles of universality and necessity compensate for adaptational problems encountered by humans in the face of a changed genetic environment—the loss of inherited patterns of action is compensated for by the ennoblement of certain "moral" norms ranked as "necessity"—and in the face of a changed social environment—the increasing complexity of sociation exerts cultural selection pressure on "universality". Universality and necessity thus make "sense" from the perspective of evolutionary theory, albeit not in the same sense as is intended by disciples of KANT. The sense of these concepts is their evolutionary function. However, universality and necessity are then basic problem formulas but not solutions. The categorical imperative is like a guidepost which shows the direction but does not travel the path. On the other side of genetic survival superiority as the trivial basic norm of every life, also cultural evolution will for this reason go an accidental (i.e. stochastically limited) direction despite the moral relevance of certain values and norms, and only those who reach the end will experience universality and necessity in a singular coincidence. It is, however, possible that they will only hear (as Niklas LUHMANN conjectured) "in der Ferne ein höhnisches Gelächter" (cf. LUHMANN 1978, p27).

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Notes

1 Rupert RIEDL was told that LORENZ did not read any further than the preface of the 2nd edition. In addition, he obviously only skimmed his copy which is still available (in his villa in Altenberg near Vienna); signs of use can only be found on the first pages of the book.

2 KANT does play a role where a differentiation is made between morality based on conscious effort and one based on cultivating natural inclinations, with the first position being that of KANT and the second being that of evolutionary ethics: "Sagt die eine Seite, wahre Sittlichkeit erweise sich erst in der Überwindiung natürlicher Neigungen, in der Bekämpfung des sog. 'inneren Schweinehundes', so fragt die andere dagegen, ob der Mensch denn von Natur aus so falsch konstruiert sei, daß er, um gut zu handeln, ständig gegen seine Konstruktion ankämpfen müsse" (VOGEL 1986, p468).

3 Pure reason "bedeutet für KANT immer, daß es *notwendig* so ist, wie es ist. Wenn überhaupt 'reine' Vernunft bestimmt, bestimmt sie daher mit Notwendigkeit" (SCHWEMMER 1983, p10).

4 The wording here is imprecise. Strictly speaking, mental images, as dreams have shown, can be presented in contradiction to one another. Seen in this manner, they cannot be "falsified". As communication, mental images can fail as a result of one another on condition that the *negation*, the *principle of identity*, the *tertium non datur* and the final rule *modus ponendo ponens* apply (with respect to these necessary conditions, see the critical argumentation of LENK 1970).

5 "Gerne dien ich dem Freunde, doch leider aus Neigung; drum wurmt es mich, daß ich nicht tugendhaft bin".—SCHILLER's ingenious parody of KANT (from the *Xenien*) is perhaps the most well-known (literary) example.

6 PLATO, in his "Republic," saw a clear understanding of the improbability of social virtues in society. Instead of establishing and maintaining abstract social relationships, people prefer to "sleep and yawn". For the majority, "persuasion and coercion" are required for a functioning social system *qua* state which can no longer be (solely) maintained by (personal) interaction. Only a minority (the "watchdog" philosophers) is able, thanks to a sophisticated and comprehensive education ("*paideia*"), to uphold this new form of sociation. It must, however, work against natural tendencies (to "sleep and yawn") which, as is shown in the allegory of the cave in Book 7, "hurts". The situation in which the cave dwellers are turned around and led to the light (of the fire and the sun) is described as "coercion". Being turned around and led by education is thus a struggle against natural inclinations (cf. PLATO 1988; TREML 1992, pp121ff).

7 "Das Ethos der Nächstenliebe is das familiäre, es ist zuerst innerhalb der Großfamilie lebendig, aber der Erweiterung fähig, bis es der Idee nach die ganze Menschheit umfaßt" (GEHLEN 1970, p121).

8 "Das Subjekt ist das Allgemeine, aber nicht als eine fertige Form, sondern als Reflexion und geschichtliche Vermittlung des für sich offenen Weltverhältnisses selbst..." (KÜMMEL 1970, p243).

9 For more information on this idea see in particular APPEL/WIMMER 1980, pp185ff. From this perspective, the KANTIAN concept of reason expresses what Wolfgang WELSCH called "transversality:" the ability, when thinking or acting, to transcend limits and thus establish larger connections (cf. WELSCH 1997).

10 "Es gibt nur die *Forderung,* den *Anspruch,* und diese kann man sehr wohl erklären, wenn auch nicht evolutionsbiologisch. Praktizierte Feindesliebe gibt es dagegen nicht!, und was es nicht gibt, braucht man auch nicht zu erklären" (Gerhard VOLLMER in DAECKE/BRESCH 1995, p119).

References

Anacker, U. (1974) Reason. In: Krings, J. /Baumgartner, H. M./Wild, C. (eds) Handbuch philosophischer Grundbegriffe. Munich: Koesel, pp. 1597–1612.

Ballauf, T./Schaller, K. (1970) Pädagogik. Eine Geschichte der Bildung und Erziehung. Vol. II. Vom 16. bis zum 19. Jh. Freiburg. Munich: Alber.

Coulmas, P. (1990) Weltbürger. Geschichte einer Menschheitssehnsucht. Reinbek bei Hamburg: Rowohlt.

Craemer-Ruegenberg, I. (1983) Logische und andere Eigenschaften des kategorischen Imperativs. Neue Hefte für Philosophie 22: 44–61.

Daecke, S. M./Bresch, C. (1995) Gut und Böse in der Evolution: Naturwissenschaftler, Philosophen und Theologen im Disput. Stuttgart: Hirzel.

De Waal, F. (1997) Der gute Affe. Der Ursprung von Recht und Unrecht bei Menschen und anderen Tieren. Munich, Vienna: Hanser.

Dugatkin, L. A. (1997) Cooperation among Animals: An Evolutionary Perspective. Oxford: University Press.

Eisler, R. (1994) Kant-Lexikon. Hildesheim, Zurich, New York: Olms.

Gehlen, A. (1970) Moral und Hypermoral. Eine pluralistische Ethik. Frankfurt a. M., Bonn: Athenaeum.

Höffe, O. (1992) Universalistische Ethik und Urteilskraft: ein aristotelischer Blick auf Kant. In: Honnefelder, L. (ed) Sittliche Lebensform und praktische Vernunft. Paderborn: Schoeningh, pp. 59–82.

Hösle, V. (1997) Moral und Politik. Grundlagen einer politischen Ethik für das 21. Jahrhundert. Munich: Beck.

Kant, I. (1877) Kritik der reinen Vernunft (KrV – Critique of Pure Reason). Leipzig: Reclam.

Kant, I. (1995) Zum ewigen Frieden (ZeF – Perpetual Peace). Berlin: Akademie.

Kant, I. (1959) Grundlegung zur Metaphysik der Sitten (MdS – General Introduction to the Metaphysic of Morals). Stuttgart: Reclam.

Kant, I. (1964) Schriften zur Anthropologie, Geschichtsphilosophie, Politik und Pädagogik. Darmstadt: Wissenschaftliche Buchgesellschaft.

Kant, I. (1973) Kritik der praktischen Vernunft (KpV – Critique of Practical Reason). Stuttgart: Reclam.

Kleingeld, P. (1995) Fortschritt und Vernunft. Zur Geschichtsphilosophie Kants. Würzburg: Koenigshausen und Neumann.

Kümmel, F. (1970) Über den Anspruch des Allgemeinen, wirkliches Allgemeines zu sein. Zeitschrift für philosophische Forschung (24) 2: 224–252.

Lenk, H. (1970) Philosophische Logikbegründung und rationaler Kritizismus. Zeitschrift für philosophische Forschung (24) 2: 183–205.

Lorenz, K. (1941/42) Kants Lehre vom Apriorischen im Lichte gegenwärtiger Biologie. Blätter für Deutsche Philosophie 15: 94–125.

Lorenz, K. (1942) Die angeborenen Formen möglicher Erfahrung. Zeitschrift für Tierpsychologie (5) 2: 236–409.

Lorenz, K. (1965) Über tierisches und menschliches Verhalten, vol. 1. Munich: Piper.

Lorenz, K. (1978) Vergleichende Verhaltensforschung. Grundlagen der Ethologie. Vienna, New York: Springer.

Luhmann, N. (1978) Soziologie der Moral. In: Luhmann, N./ Pfürtner, S. H. (eds), Theorietechnik und Moral. Frankfurt a. M.: Suhrkamp.

Mohr, H. (1987) Natur und Moral: Ethik in der Biologie. Darmstadt: Wissenschaftliche Buchgesellschaft.

Monod, J. (1977) Zufall und Notwendigkeit. Philosophische Fragen der modernen Biologie. Munich: Deutscher Taschenbuch Verlag.

Plato (1988) Republic. Sämtliche Dialoge. Otto Apelt (ed). Hamburg: Meiner.

Riedl, R. (1980) Biologie der Erkenntnis. Die stammesgeschichtlichen Grundlagen der Vernunft. Hamburg, Berlin: Parey.

Schwemmer, O. (1983) Die praktische Ohnmacht der reinen Vernunft. Bemerkungen zum kategorischen Imperativ Kants. Neue Hefte für Philosophie 22: 1–24.

Singer, M. G. (1975) Verallgemeinerung in der Ethik. Frankfurt a. M.: Suhrkamp.

Sommer, M. (1983) Mit dem Zufall leben. Überlegungen zu Kants Moralphilosophie. Neue Hefte für Philosophie 22: 95–112.

Treml, A. K. (1982) Theorie struktureller Erziehung. Grundlagen einer pädagogischen Sozialisationstheorie. Weinheim and Basel: Beltz.

Treml, A. K. (1992) Überlebensethik. Stichworte zur praktischen Vernunft im Horizont der ökologischen Krise. Tübingen, Hamburg: Schoeppe und Schwarzenbarth.

Treml, A. K. (1996) Die Erziehung zum Weltbürger. Und was wir dabei von Comenius, Kant und Luhmann lernen können. ZEP—Zeitschrift für internationale Bildungsforschung und Entwicklungspädagogik 1/96: 2–8.

Treml, A. K. (1999) Klassiker. Die Evolution einflußreicher Semantik. Band II. Einzelstudien: Comenius, Leibniz, Rousseau, Kant, Goethe, Steiner. Sankt Augustin (forthcoming). Academia.

Vaihinger, H. (1986) Die Philosophie des Als-Ob. (Reprint of the 1927 Leipzig edition). Aalen: Scientia.

Vogel, C. (1986) Evolution and Moral. In: Maier-Leibnitz, H. (ed) Zeugen des Wissens. Mainz: Hase und Koehler, pp. 467–508.

Vollmer, G. (1988) Sollen impliziert Können. Kritischer Realismus als Grundlage einer evolutionären Ethik. In: Sievering, U. O. (ed) Kritischer Rationalismus heute. Frankfurt a. M.: Haag und Herchen, pp. 181–210.

Welsch, W. (1997) Transversale Vernunft. Vernunft muß sich der Pluralität und Unordentlichkeit stellen. Ethik und Unterricht 2/97: 8–13.

Wimmer, R. (1980) Universalierung in der Ethik. Analyse, Kritik und Rekonstruktion ethischer Rationalitätsansprüche. Frankfurt a. M.: Suhrkamp.

Wuketits, F. (1993) Verdammt zur Unmoral? Zur Naturgeschichte von Gut und Böse. Munich: Piper.

Thomas Mohrs

Kant's Philosophy of History from an Evolutionary Point of View

Abstract

In this article, I will try to combine an important aspect of KANT's philosophy—precisely his philosophy of history—with an evolutionary, sociobiological approach. At first glance, this seems to be simply absurd. However I will try to show that there are good reasons for this combination not only concerning research of KANT's philosophy in general but also for future reflections on modern society and its present political problems.

For this purpose, my ideas concerning a sociobiological reconstruction of KANT's philosophy of history will be discussed in the following way: after a closer look at KANT's philosophy of history and the equivalent evolutionary thesis I will investigate the question whether these approaches in principle are compatible. Thereafter I will in detail discuss an essential difference between the two theoretical approaches. I will then end with a plea for KANT's "pragmatic optimism".

Key words

Sociobiology, biopolitics, KANT, philosophy of history, moral philosophy, "laws" and "aims" of historical development, globalization, pragmatic optimism, "world-republic of liberal republics".

THE QUESTION ONE might want to pose, is, whether the attempt to combine Immanuel KANT's philosophy with evolutionary or sociobiological theory is not really, so to speak, "a priori" absurd. This question probably will rise almost automatically, because we have come to see KANT as the prototype of the idealist moral philosopher, as the author of the categorical imperative and of the autonomy and freedom of the moral subject for which alone and always the measure of truth is to be found in itself, that is in reason. How then should it be possible to reasonably combine this philosophy with a tight materialist and evolutionary approach such as that of sociobiology, which solidly puts the idea of an autonomous and independent human will in question? Wouldn't this mean to deny KANT's philosophy as a whole?

The title of this article therefore will at first glance seem to be a clear and simple provocation. However this is not what I intend. It is not the aim of this paper to generally reflect on KANT and the theory of evolution or to consider the philosophy of Immanuel KANT as a whole in the light of sociobiology. On the contrary, the focus of my analysis will only be KANT's philosophy of history and its relation to sociobiology. I will attempt to demonstrate not only that this is a fundamentally different approach but also that it is reasonable to critically redefine KANT's philosophy of history from the point of view of evolutionary theory. This will in my opinion be of sound value for future reflections (and academic discourse) concerning modern society and its present political problems.

However, before I turn to the main subject of this paper I would like to confront a number of obvious objections:

a) There might be doubts, whether the transfer of a certain philosophy of history or political theory from an 18th century philosopher into our own age is admissible simply because of the different economic, social, political and also ecological conditions.

These doubts can be encountered by the following argument: KANT was not primarily interested in questions of particular historical events but in principles of history in general. KANT held these principles to be valid for all times. According to KANT, in every stage of history the same uniform principles may be applied. His pretension was that this would hold true not only for the past, but also for future ages. (These arguments of KANT's can quite well be supported by the sociobiological premise that from an evolutionary (or genetic) point of view man[1] nowadays doesn't differ from his or her ancestors of 30.000 to 50.000 years ago. Therefore with respect to the anthropological foundation of KANT's philosophy of history, it can be said that KANT's concept of man is basically the same

as that of today's sociobiology. As HUME puts it: "It is universally acknowledged that there is a great uniformity among the actions of men, in all nations and ages, and that human nature remains still the same, in its principles and operations. […] Mankind are so much the same, in all times and places, that history informs us of nothing new or strange in this particular" (HUME 1975, p83).

I'm going to return to this subject later. For the moment let it suffice to say that this seems to be a good enough reason to critically analyze an elder philosophy of history such as KANT's from the point of view of modern evolutionary theory, the centre of investigation being these timeless 'principles of history' accepted by KANT.

b) Is it at all feasible to apply scientific concepts from evolutionary biology to history? Doesn't this imply a confusion of fundamental categories? The argument might be that history and historiography really are idiographic sciences, that is humanities in the spirit of Windelband, so that it would be inadmissible from the start to apply nomothetic concepts.

At least two reasons speak out against this: Firstly, KANT did not understand his philosophy of history in the sense of a purely idiographic science. Rather, KANT was looking for arguments to support a theory of universal principles and (natural) laws of history. Therefore, with respect to KANT's own purpose it would be more appropriate to regard his philosophy of history as a nomothetic venture.

The second argument, which is certainly the more far-reaching of the two, is that an application of sociobiological theses to history and political science must be valid or acceptable just because the subject of these sciences is of course mankind, that is human beings. But if we humans do actually fit into sociobiological theory (our system characteristics being somehow "the outcome of biological evolution") and if our thoughts, actions and behaviour at any time in history are of a physiological nature which is not "completely arbitrary or structurally amorphous" and further, if all our cultural goods and political institutions somehow are interrelated with our genetic condition, then it would seem that no single part of human life, including history and politics, can in principle be excluded from theoretical evolutionary research. (KANITSCHEIDER 1997, pp14ff; FLOHR 1984, p64; FLOHR 1985, p94; VOLAND 1996, p102, p104)

In addition to that, another part of my motive for discussing KANT and sociobiology, is to propagate a somewhat different picture of KANT. KANT is often reduced to the concept of categorical imperative and his rigorous moral, combined with the critic that to start with the categorical imperative is futile and that the rigorism represents nothing less than an inhumane postulate. As to this interpretation, KANT's moral philosophy simply can not be lived. This seems to me to be basically correct. At the same time I am of the opinion that KANT being one of the most realistic, serious and non-illusionist political and anthropological thinkers of the history of philosophy, surely was aware of all this. Especially in his treatises on philosophy of history and politics, he assumed the point of view of an almost brutal realism concerning the anthropological premises. This realism provides good reasons for a sociobiological understanding; for an approach that will possibly throw a new and very specific light on his moral works in general.

The theoretical basis: The doctrine of the "original condition"

Let us now take a closer look at the theoretical basis of KANT's philosophy of history. All through his political philosophy KANT follows the original thesis of HOBBES that previous to the occurrence of states, man found himself in a so-called "original condition".

Characteristic of this original condition was the total lack of legal norms and therefore of legal safeguards, legal recourse and forms of arbitration (no courts), or any other legal means to obtain or assert justice. Under these conditions every individual had an innate right to everything and everyone had to see how to come into his or her own right. Each individual was at the same time his or her own lawgiver/legislator, governor and judge. Under such conditions, the competition between individuals for the scarce resources must have been very hard, so that, actually, the "original condition" was a condition of "warre, as is of every man, against every man" (HOBBES 1992, p88). In other words, it was a condition of complete lawlessness with violence and deceit being cardinal virtues. "In such condition, there is no place for Industry; because the fruit thereof is uncertain: and consequently no Culture of the Earth; no Navigation, nor use of the commodities that may be imported by Sea; no commodious Building; no Instrument of moving, and removing such things as require much force; no Knowledge of the face of the Earth; no account of Time; no Arts; no Letters; no Society; and which is the worst of all, continuall fear, and danger of violent death. And the life of man, solitary, poore, nasty, brutish, and short" (HOBBES 1992, p89).

However the original anxiety is followed by a kind of reason; man came to understand that for everyone it would be better if the condition of lawlessness came to an end. And as to the general moral unreliability of man they called for a common authority in order to safeguard their rights and, in case of their violation, to use the "sword of justice". In the end, the misery of the "original condition" forced the individuals to create institutional structures right down to the modern state as "precincts", as KANT phrases it, just to make them able to "exist side by side" on a fairly long term basis.[2]

However, KANT modified HOBBES' model in two important points:

a) Firstly, in contrast to HOBBES, KANT assumed that there actually existed a historical phase of "original conditions". This was, according to KANT, the period between man's existence as hunter and gatherer and that of farmer and cattle breeder. In his literary "pleasure trip" about "Conjectures on the Beginning of Human History" from 1785 KANT wrote: "Where people depend for their livelihood on the cultivation of the soil (and the planting of trees in particular), they require permanent accommodation; and the defence of such property against all encroachment requires a large number of people who are prepared to assist one another. Hence those who adopted this way of life could no longer live in scattered family units, but had to stick together [...] in order to protect their property against savage hunters or tribes of pastoral nomads."[3] Compared to a living as hunter and gatherer, this form of life was arduous and insecure. Moreover, it depended on the possession of private land and its effective use. In KANT's opinion, it also depended on "sufficient strength" so that the territory could be defended.

However, in contrast to the matter–of–fact–reality of the "original condition", KANT considered the "original *contract*" to be an "*idea* of reason" alone. In KANT's opinion, this "contract (*contractus originarius or pactum sociale*) [...] actually exists as a fact, for it cannot possibly be so."[4] In other words, according to KANT, the theorem of the actual making of an original contract is founded on a mere assumption. For KANT, and by the way, for HOBBES as well, it was evident that the actual formation of states originally grounded in acts of conquest, subjugation or forced assimilation.

b) Furthermore, KANT considered even the purely hypothetical assumption of a completely isolated human existence in an "original condition" as untenable. As to KANT, the "original condition" cannot be understood as a state of continuous violent conflict between individuals alone, but rather between small clusters of humans, families, kinship groups and clans. Within these small groups themselves—according to KANT—prevailed an atmosphere of (unsociable) sociability and general benevolence.

With the "fencing in" of man in state–"enclosures", the "original condition" was in a threefold dialectic sense suspended. On the one hand, people could succeed within their secure communities to economically and culturally improve their civilization (cf. Conjectures, pp230f). On the other hand, between the states themselves nothing changed: They still remained in a condition of constant lawlessness and conflict ("war of all against all"). They continued this "farce" simply at a higher level and with other means, which in KANT's words "cannot give any higher a value to mankind than to the other animal species, whose interaction takes place at less cost and without any conscious understanding".[5] For this reason, watching the activities of humankind "in the great world-drama", KANT could reasonably summarize, "that we do not know what sort of opinion we should form of our species, which is so proud of its supposed superiority" (Idea p34). In this context it is important to realize that the "state of war" in KANT's usage not only meant war in its stricter definition as a violent conflict but rather "the very fact that they [i.e., the states] are always prepared for it".[6]

As to KANT, the formation of state–"enclosures" had at least on the surface nothing to do with ideal conceptions, moral views or moral reflections. Rather it was to be regarded as the "inevitable outcome of the distress" (Idea p48) which people were *forced* to choose in order to survive.

Furthermore, (still following the "Logic of Leviathan") even for competing small groups there can be at the end "only one rational way in which states coexisting with other states can emerge from the lawless condition of pure warfare. Just like individual men, they must renounce their savage and lawless freedom, adapt themselves to public coercive laws, and thus form an *international state* (*civitas gentium*), which would necessarily continue to grow until it embraced all the peoples of the earth" (Peace p105). And analogous to small groups it is not moral reflection or moral understanding that guides states on the way out of their squalid "original condition". Rather, here as well, it is the consequence of bare necessity. As KANT puts it in his "Idea for a Universal History With a Cosmopolitan Purpose" (1784):

"However wild and fanciful this idea [of the international state] may appear [...] it is nonetheless the inevitable outcome of the distress in which men in-

volve one another. For this distress must force the states to make exactly the same decision (however difficult it may be for them) as that which man was forced to make, equally unwillingly, in his savage state—the decision to renounce his brutish freedom and seek calm and security within a law-governed constitution" (Idea pp47f). Even more plainly KANT phrased this logic of a "civitas gentium" in his work "On the Common Saying" (1793) in which he wrote: "On the one hand, universal violence and the distress it produces must eventually make a people decide to submit to the coercion which reason itself prescribes (i.e., the coercion of public law), and to enter into a *civil* constitution. And on the other hand, the distress, produced by the constant wars in which the states try to subjugate or engulf each other must finally lead them, even against there will, to enter into a *cosmopolitan* constitution" (Common Saying, p90).

Thus in his political philosophy KANT consequently went beyond HOBBES in that he applied the basic "original conditions"–theorem, the "theory of pauperization" and the resulting "Logic of Leviathan" to the international level as well. And he came to the corresponding conclusion that a real, lasting, stable and safe world-wide peace could solely be achieved in a yet to be created world republic with a common legal system and a global governance.

The function of "the great artist nature"

It should be remarked that the above mentioned reflections can be characterized by a special dialectic "highlight", as KANT, in order to support his assumptions, appeals to a teleological construction of nature (that is history). More precisely, he asserts that it is *not* the rational and moral human insight from which the development of a virtuous and accomplished world-system (constitution) is to be expected. Rather, the evolution of mankind towards a completion of its natural potential is guaranteed by "no less an authority then the great artist *Nature* herself" (Peace p108; cf. Contest p184; FRÖHLICH 1997, pp500ff). As to KANT, nature continually and intentionally follows "a regular course in leading our species gradually upwards from the lower level of animality to the highest level of humanity..." (Idea p48). Though the means by which the "great artist nature" makes use of her "*hidden plan*" (Idea p50) are, as KANT saw it, not human reason and the capability of moral insight, but rather—paradoxically—"their very discord" (Peace p108), that is, man's "social incompatibility, enviously competitive vanity, and insatiable desires for possession or even power" (Idea p45) and in particular also the "*spirit of commerce*" (Peace p114; cf. Idea p50).[7] Without the fundamental and inevitable power of human egoism there would be no social, political, cultural and also no moral evolution and "man would live an Arcadian, pastoral existence of perfect concord, self-sufficiency and mutual love. But all human talents would remain hidden for ever in a dormant state, and men, as good natured as the sheep they tended, would scarcely render their existence more valuable than that of their animals" (Idea p45).

The compatibility of Kant and "biopolitics"

Especially the above mentioned evolutionary aspects of KANT's philosophy of history appeared to me to be very promising as to a critical review from a point of view of an evolutionary model. In the relevant (sociobiological) literature the appropriate model is called "biopolitics".

In the broadest sense "biopolitics" stands for all attempts to make evolutionary biological, ethological and sociobiological concepts, methods and scientific results productive for research in general and for the explanation of political phenomenons on every level (e.g., PHOCAS 1986; WIEGELE 1979; WIMMER 1996, pp27f; SARETZKI 1990, pp85ff). The central idea of evolutionary theory implies that man is just another living organism and therefore no less dependent upon nature. Human beings, including all of their specific system-characteristics like reason, consciousness, reflection and moral thinking, are nothing but the outcome of biological phylogenesis. A radical-behaviourist's view, on the contrary, would see humans as purely cultural beings and would categorically dispute any relevance of biology for their explanation and understanding. However, such a point of view is rejected by the advocates of "biopolitics" as untenable because it must necessarily end in a "culturalistic fallacy" (FLOHR 1982, p203; FLOHR 1990, p49; SARETZKI 1990, pp87f).

Some other central anthropological theses of "biopolitics" are:

- Human beings naturally are small group animals. We are programmed to live and to survive in rather small and transparent social clusters which originally were defined by their genetic kinship.
- The members of each cluster or "ingroup" tend—notwithstanding their inter-individual competition (especially for sexual partners as well as in connec-

tion with hierarchical status)—to a rather sociable, altruistic behaviour.

■ On the other hand, with regard to other members of the same species who are not genetically akin (i.e., the members of "outgroups"), we naturally tend to a (at best) "adiaphoric" and indifferent behaviour. This indifference can and often will (e.g. in conflicts about rare resources) develop from different forms of xenophobia into massive aggressiveness.

■ For the sake of the comparatively slow course of our cultural evolution it must be assumed that, with regard to our genetic "settings" (including also our genetic–biological behaviour patterns), "modern man" does not differ from post-glacial Neolithic human beings.

The occurrence of states from a "biopolitical" point of view

The central question now is how, with regard to this premises, the origin of society and modern states can be explained from the prospect of "biopolitics". The parallels to the above presented KANT-model will often be evident so that most of the times, they don't even have to be mentioned.

According to "biopolitical" thought the most important reason for the end of the original way of life as nomadic hunters and gatherers in small family groups was overpopulation. Even though during that period the population growth should have been rather modest, this gradually must have led to an exhaustion of vital resources and of land accessible for humans. Accordingly the competition for vital resources must have become crucial. This precarious situation caused the so called "Neolithic revolution". The term "Neolithic revolution" (recently critically discussed in WIMMER 1996, pp121–131) marks the process of human domestication, starting from nomadic hunters and gatherers and ending in a settled way of life as farmers and cattle breeders. In this stage of human evolution, more "progressive" groups began cultivating smaller but closely defined segments of land with higher efficiency. This resulted in a change of diet and a more exactly defined division of labour as well as a change in the birth-rate. For instance it was no longer necessary for women to carry their babies over great distances, which was the main reason for the comparatively low birth-rate of nomadic women. The above mentioned factors in combination with the growing need for more labourers as a result of the new agricultural methods caused Neolithic man to change his birth-strategy and to give up the strictly limited birth-rate. The increase of population led towards an improvement and intensification of land use and animal husbandry. The following growth in crop yields on its part gave positive feed-back to the increase of population. This in return became the driving force for innovations in technology and productivity etc., etc. (cf. MARKL 1982, pp627–663).

Another important aspect caused by this transformation towards a settled way of life was that in defence of their territory, farmers and cattle breeders became ever more aggressive. This was a consequence of the need to ensure permanence of land ownership and preclusion of others from its use. To quote KANT again: contrary to the "savage life of the hunter […] *Agriculture* or the planting of crops, on the other hand, is extremely laborious, subject to the vagaries of climate, and consequently insecure; it also requires permanent settlements, ownership of land, and sufficient strength to defend the latter" (Conjectures, p229).

It seems obvious that as a result of the population growth it would regularly come to an overstrain of cultivated land. This finally led to a point where it was no longer possible to alleviate the problems by expansion into new regions for the simple reason that no more land stood free. This regularly brought about very intensive, aggressive and bloody conflicts between competing groups, especially when a certain group tried to expand. The scriptural story in which Cain the farmer kills Abel the hunter, provides a good metaphor for the situation of mankind since the Neolithic revolution. We have now come to know the plausible evolutionary explanation for the murderous human "farce", which KANT observed and which fed his deep suspicions concerning humanity.

According to KANT and also to "biopolitics", in this wretched "original condition" it is only by means of reason that man comes to understand that in order to survive the social circumstances have to be changed. In addition to that, it is also realized by reasoning that alternatives to the status quo should be anticipated, such as the way out of the "original condition" through alliances with other, genetically non-akin groups, the gradual extension of these purposive alliances to repulse or combat other rivalling alliances (cf. NOZICK 1976, pp25–38) and in this connection the socialization, the necessity of creating rules for stabilizing and securing the internal relations of the alliance which otherwise are not controllable any more, and finally the nationalization. KANT makes it quite plain that the "task" of finding a way

out of the "original condition" actually has nothing to do with "morality": "For such a task does not involve the moral improvement of man; it only means finding out how the mechanism of nature can be applied to men in such a manner that the antagonism of their hostile attitudes will make them compel one another to submit to coercive laws, thereby producing a condition of peace within which the laws can be enforced" (Peace p113).

It is possible to abridge the argumentation at this point as it is not necessary for the comparison of sociobiological considerations and KANT's philosophy of history to exactly depict the phases and factors which are differentiated in detailed "biopolitics"–research (for detailed account see PHOCAS 1986, pp121–124). For us, only the central thesis is of importance, according to which in the course of the development of social and political structures, which originated in competing kin-groups, after many thousands of years the modern nation state had emerged. This implies the thesis that modern states have gradually evolved from divers evolutionary "steps". In other words, the occurrence of modern states depends upon the same evolutionary "laws" as any other of the "lower-level" organisational forms of human societies.

- main factor is the overstrain of the supporting capacities of ecological "niches" resulting from an increase in population and/or shortage of resources (e.g. "overkill" of huntable animals);
- it follows a decline of survival and reproduction conditions
- this results in an intensification of the competitive situation and conflicts between different groups
- it follows an intensified pressure imposed by suffering and—in case aggressive strategies such as expulsion, subjugation or genocide for a longer time are not successful—the necessity to look for and slowly develop more alternative, more co-operative that is, social strategies in order to solve the problems. And even if aggressive strategies had been successful, some day societies' sheer size and complexity forced them to regulate their inner stability and security by appropriate institutions (cf. PHOCAS 1986, pp121–133).

The crucial question: What is the consequence?

As we have seen, at least the central ideas of KANT's philosophy of history can quite easily be re-defined from an evolutionary point of view. Yet at this point there inevitably rises the crucial question as to its practical and political consequences. The practical result might be that KANT was right and that accordingly human history followed and still follows a plan of the "great artist nature". In consequence of this history-ruling plan, the realization of eternal peace on earth within KANT's "world-republic of liberal republics", would only be a matter of time. However, this is definitely not the case!

Firstly, KANT himself had serious doubts with regard to the possibility of realizing this "world-republic of liberal republics", which he repeatedly called a "sweet dream" (cf. Contest p188) or "an idea incapable of realisation"[8]. Furthermore he was completely aware of the speculative content of his teleological model of history. For KANT the question of progress, standstill or atavism in human history could not be answered in terms of a theoretical proof. There are no hard empirical facts to be found which could ultimately verify a "purpose" or "telos" of nature. The *critical* main argument of Kantian philosophy of history is actually that it is impossible to get to know anything about a possible unity and "meaning" of history and its course (cf. KLEINGELD 1995, pp215ff).

Secondly, any reliable "biopolitics"–theorist will reject the historicist thesis that history necessarily develops as a result of nature's inherent laws as well as the radically anthropocentric thesis that nature in the end "aims" at the accomplishment of natural human capabilities (for further controversial discussions see WIMMER 1996, pp22ff; LABERGE 1995, p150; KLEINGELD 1995, pp128–132, pp137ff; VOLAND 1996, pp103ff).

As to modern international communities one can point out that institutions like UNO, GATT, WTO, EU or NATO are actually continuing this process which starting from the size of small groups after many millenniums (of history of humanity) has yielded the organizational level of states. However this evolutionary process is not to be seen as a consequence of historical necessity or of coercive natural laws, but as contingent and highly unstable occurrence. More precisely: The alternative scenario that, at the very moment in which for example an extreme world-wide shortage of resources caused by a rapid increase in population will occur, no universal co-operative strategies or world-wide solidarity might be found, but that a relapse into archaic strategies of problem-solving might take place—and consequently the collapse of the international communities in a possible "clash of civilizations" (HUNTINGTON 1997)—is from a sociobiological point of view no

less probable than the realization of KANT's dream. (By the way, KANT considered both alternatives too at the end: firstly, he took into account the brittleness of progress, when he wrote that it could at any time come to a turning point from which the development could take a different direction. Secondly, his critical attitude concerning the (apparently consistent) formation of a world-state can be understood as a reference to possible scenarios of realist politics and its conviction that man actually does not really want what "in thesi" would be the right thing (Peace p105; cf. Contest p180). In other words, KANT also was aware of the possibility of a great "clash" and he quite ironically remarked that "perpetual peace" indeed could be achieved "on the vast graveyard of the human race" (Peace p96).

Thirdly, a naive understanding of the "sweet dream" of a law-governed human history naturally contains the great danger of "idle loafing": If the course of humanity "in the long run" were predetermined, wouldn't it be ridiculous to fight nature and therefore futile for a single human being to try to help "the great artist nature"? Thus if everything was going to come as it must, we could just sit back and see if we were being given the opportunity to take part in the last act of the great "farce" of human history or not.

A very similar danger is also to be found in a normative fallacy resulting from sociobiological fundaments according to which humans are small group animals, genetically programmed to live in small transparent groups and therefore strictly limited in their ability to think, decide and act. If one wants to derive from this, because of his or her genetic disposition, man will simply find it impossible to match the ever increasing intercultural and global requirements of today's world, it seems that this must end in fatalism.

Conclusion: A plea for Kant's pragmatic optimism

But can the fatalistic position be accepted as a responsible alternative if we take into account that nowadays, especially in politics, an ever increasing (selectional) "adaptive pressure" in the direction of universal or global behaviour patterns can be observed? (A pressure that also produces from within a contra tendency to re-nationalization or regionalization as a dialectical reaction to a feeling of alarm in the face of globalization. How to cope with the resulting tensions and reprobations will probably be one of the prevailing problems of the twenty-first century.)

The clear-headed realist KANT admits unhesitatingly that no one can be blamed "if political evils make him begin to despair of the welfare and progress of mankind" (Contest p189). Still he resolutely pleads for an optimism in philosophy of history. And his main argument for this optimism is at the same time a lesson in pragmatism (and additionally a clear rejection to transferring philosophical scepticism into political practice): It is impossible to provide a valid proof for the thesis that human history by (natural) necessity proceeds towards an—a priori—determined purpose (i.e., humanity's *opportunity* of completing its moral development in a "world-republic of liberal republics"). *Yet at the same time it is impossible to prove the opposite.* Accordingly, KANT's simple but decisive question was: confronted with this aporia, what should we wish to believe with regard to the further development of humankind? Should we assume

a) that a positive development could only be expected in case of "an EPICUREAN concourse of efficient causes", a "lucky accident", "which is hardly likely ever to occur" (Idea p48)?

b) that "nothing at all, or at least nothing rational, will anywhere emerge from all these actions and counter-actions among men as a whole" (Idea p48), so that the whole "interplay of our species on earth" had to be really regarded as a mere "farce"? Or should we assume

c) that "*history of the human race as a whole can be regarded as the realisation of a hidden plan of nature to bring about an internally—and for this purpose also externally—perfect political constitution as the only possible state within which all natural capacities of mankind can be developed completely*" (Idea p50)?

To repeat it once again: None of these possibilities can be proved correct. Yet for KANT solely the third, optimistic idea of historical development is acceptable and reasonable because it corresponds with—as he is convinced—the *need of practical reason* for a moral content and purpose of history (for detailed account see KLEINGELD 1995, pp89–109).[9] At the same time this idea which KANT once called one of the legitimate "*chiliastic* expactations" of philosophy (Idea p50)—in his opinion is not a mere utopia and "anything but overfanciful" (ibid.). Rather it has got an objective reality as it is part of its realization in itself:

"But how is it possible to have history *a priori*? The answer is that it is possible if the prophet him-

self occasions and *produces* the events he predicts" (Contest p177).

Quite apart from the fact that especially from an evolutionary point of view the life-supporting function of a positive world-view per se is easy to comprehend, KANT's pragmatic optimism can for other reasons too at least partly be confirmed by sociobiology—provided that any genetical determinism will be rejected.

Man is—according to the sociobiological interpretation—a conditional creature. Among his or her most important and successful inherent characteristics are his/her capacity to learn and his/her enormous flexibility of behaviour. Exactly in the sense of KANT's optimism but without being forced to share his moral idealism we can and may proceed by assuming that we are able to adequately adapt to the new survival conditions in the century of globalization and thus to overcome our phylogenetical heritage somehow (cf. COHEN 1996, pp74ff; HONNETH 1996, p275). By analogy with KANT's repeated attempts to mention at least empirical "clues" in order to prove his thesis of the modern development of the "human race", one could as well assert that humanity has already demonstrated effectively that she is capable of developing divers forms of *common identity* beyond small groups. Thus humanity already has shown that the thesis of the basic incapacity to actually transcend genetic restrictions empirically is simply wrong.

At the same time sociobiology might serve another important function as it constantly reminds us of the fact that concerning our genetical "programming" we are not directly prepared for life in global contexts. For this reason we should be prepared for difficulties and considerable resistance in all political spheres. Moreover, to demand that in political planning and execution biological factors influencing our ways of thinking and our behaviour in this direction should be taken into consideration, implies no naturalistic fallacy. On the contrary, it expresses moral realism and political wisdom.

Finally I want to emphasize once again the important and possibly extremely challenging statement: Within the scope of these reflections on human development towards a better or more "adaptive" constitution, moral—in the strict sense of really altruistic, conscientious and dutiful behaviour serving one's own personal perfection and the blissfulness of others—plays a role neither in the sociobiological model nor for KANT, at least not primarily.

To be sure, according to KANT moral law is timeless and a priori objectively valid, and he also believes in having conceptually explained the principle of moral for all times. In his eyes furthermore it is reasonable to hope for the future day when everyone's moral understanding will be entirely enlightened and when the development of human capabilities will end up in their true and completed moralization.

However, with regard to the way towards this attainable stage KANT remarks e.g. in his "Contest of Faculties": "The profit which will accrue to the human race as it works its way forward will not be an ever increasing quantity in *morality* in its attitudes. Instead, the *legality* of its attitudes will produce an increasing number of actions governed by duty, whatever the particular motive behind these actions may be." And the development towards "more charity, less quarrels in legal actions, more reliability in keeping one's word, and so on in commonwealth" will be caused partly by "a love of honour, and partly from a lively awareness of where one's own advantage lies; and this will ultimately extend to the external relations between the various peoples, until a cosmopolitan society is created. Such developments do not mean, however, that the basic moral capacity of mankind will increase in the slightest, for this would require a kind of new creation or supernatural influence" (Contest pp187f). And in his "Idea for a Universal History with a Cosmopolitan Purpose" KANT wrote just as unambiguously that "no progress in this direction [i.e., moral maturity; T.M.] can be expected [...] until [the human race] has worked itself out of the chaotic state of its political relations" (Idea p49). Whoever expects more of "human beings in their progressive improvements" or awaits this progress from humanity's moral qualities, has—according to KANT—to put up with "the scorn of those politicians who would gladly treat man's hopes of progress as the fantasies of an overheated mind" (Contest p188).

In this passage we can observe a very modest optimism—an optimism, however, that can unhesitatingly be shared from a sociobiological perspective. It is an optimism for which—at least in my opinion—there exists no real alternative.

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Notes

1 "Man" is used here and in the whole article in a non sexist way.

2 KANT, Idea for a Universal History With a Cosmopolitan Purpose (= Idea). In: KANT 1991, p46.

3 KANT, Conjectures on the Beginning of Human History (= Conjectures). In: KANT 1991, p230.

4 KANT, On the Common Saying: 'This May be True in Theory, but it does not Apply in Practice' (= Common Saying) 1991, p79.

5 KANT, The Contest of Faculties (= Contest). In: KANT 1991, p180.

6 KANT, Perpetual Peace—A Philosophical Sketch (= Peace). In: KANT 1991, p94.

7 For further discussions see GERHARDT 1995, pp124f, pp175f; HOLZ 1996, pp46ff; LABERGE 1995, pp158–169; KLENNER 1996, pp21ff; VAN DER PIJL 1996, pp27f; SCHMID 1995, pp205f; WIMMER 1996, pp219ff; WEEDE 1997, pp13f, pp17f; very critical HUNTINGTON 1997, pp350f.

8 KANT, The Metaphysics of Morals (= Metaphysics). In: KANT 1991, p171.

9 Cf. also KANT, What is Orientation in Thinking? In: KANT 1991, p240 and KANT 1952, pp227ff

References

Cohen, R. (1996) Teleonome Prozesse und soziale Evolution: Eine lentikuläre Perspektive. In: Riedl, R./Delpos, M. (eds) Die evolutionäre Erkenntnistheorie im Spiegel der Wissenschaften. Wiener Universitätsverlag: Wien, pp. 58–79.

Flohr, H. (1982) Biopolitics—Versuche jenseits des Kulturismus. Politische Vierteljahresschriften 1/82, pp. 196–203.

Flohr, H. (1984) Darwin und die Politik. Vom Wert der biosozialen Perspektive. In: Rebe, B., Lompe, K., von Thadden, R. (eds) Idee und Pragmatik in der politischen Entscheidung. Verlag neue Gesellschaft: Bonn, pp. 43–68.

Flohr, H. (1985) Geschichtswissenschaft und Biologie. Überlegungen zur biowissenschaftlichen Orientierung des Historikers. Saeculum 36: 80–97.

Flohr, H. (1990) Die Bedeutung biokultureller Ansätze für die Institutionentheorie. In: Göhler, G./Lenk, K./Schmalz-Bruns, R. (eds) Die Rationalität politischer Institutionen. Interdisziplinäre Perspektiven. Nomos: Baden-Baden, pp. 21–57.

Fröhlich, M. (1997) Die Diskussion 200 Jahre nach Kants "Ewigem Frieden". Zeitschrift für Politikwissenschaft 2/97: 484–517.

Gerhardt, V. (1995) Immanuel Kants Entwurf "Zum ewigen Frieden". Eine Theorie der Politik. Wissenschaftliche Buchgesellschaft: Darmstadt.

Hobbes, T. (1991) Leviathan, ed. by Richard Tuck. Cambridge University Press: Cambridge.

Holz, H. H. (1996) Gedanken zu Krieg und Frieden. In: Bialas V./Häßler, H.-J. (eds) 200 Jahre Kants Entwurf "Zum ewigen Frieden". Idee einer globalen Friedensordnung. Königshausen & Neumann: Würzburg, pp. 42–54.

Honneth, A. (1996) Universalismus als moralische Falle? Bedingungen und Grenzen einer Politik der Menschenrechte. In: Lutz–Bachmann, M./Bohmann, J. (eds) Frieden durch Recht. Kants Friedensidee und das Problem einer neuen Weltordnung. Suhrkamp: Frankfurt/Main, pp. 272–299.

Hume, D. (1975) Enquiries Concerning Human Understanding and Concerning the Principles of Morals, Third Edition, ed. by L. A. Selby-Bigge. Oxford University Press: Oxford 1975.

Huntington, S. P. (1997) Der Kampf der Kulturen. Die Neugestaltung der Weltpolitik im 21. Jahrhundert, 6th edition. Europa-Verlag: München, Wien 1997.

Kanitscheider, B. (1997) Grenzen der Erkenntnis? Naturwissenschaft und Metaphysik. Information Philosophie 5/97: 6–16.

Kant, I., (1952) The Critique of Pure Reason, published by W. Benton. Encyclopaedia Britannica: Chicago, London, Toronto, Geneva.

Kant, I. (1991) Political Writings, ed. by Hans Reiss, translated by H. B. Nisbett, 2nd ed. Cambridge University Press: Cambridge.

Kleingeld, P. (1996) Fortschritt und Vernunft: Zur Geschichtsphilosophie Kants. Königshausen & Neumann: Würzburg.

Klenner, H. (1996) Kants Entwurf "Zum ewigen Frieden"—Illusion oder Utopie. In: Bialas V./Häßler, H.-J. (eds) 200 Jahre Kants Entwurf "Zum ewigen Frieden". Idee einer globalen Friedensordnung. Königshausen & Neumann: Würzburg, pp. 15–25.

Laberge, P. (1995) Von der Garantie des ewigen Friedens. In: Höffe, O. (ed) Immanuel Kant. Zum ewigen Frieden. Akademie-Verlag: Berlin, pp. 149–170.

Markl, H. (1982) Ökologie des Menschen in geschichtlicher Perspektive. Kindlers Enzyklopädie "Der Mensch", vol. II. Kindler: Zürich, pp. 627–663.

Nozick, R. (1976) Anarchie, Staat, Utopia, München.

Phocas, A. (1986) Biologische Aspekte politischen Verhaltens. Tuduv-Verlags-Gesellschaft: München.

Pijl, K. van der (1996) Von dem Entwurf Kants zur Realität der "Neuen Weltordnung". In: Bialas V./Häßler, H.-J. (eds) 200 Jahre Kants Entwurf "Zum ewigen Frieden". Idee einer globalen Friedensordnung. Königshausen & Neumann: Würzburg, pp. 26–34.

Saretzki, T. (1990) Biopolitics—ein erklärungskräftiger Ansatz für die Theorie politischer Institutionen? In: Göhler, G./ Lenk, K./Schmalz-Bruns, R. (eds) Die Rationalität politischer Institutionen. Interdisziplinäre Perspektiven. Nomos: Baden-Baden, pp. 85–114.

Schmid, M. (1995) Soziologische Evolutionstheorie. Proto Soziologie 7: 200–210.

Voland, E. (1996) Konkurrenz in Evolution und Geschichte. Ethik und Sozialwissenschaften (7) 1: 93–107.

Weede, E. (1997) Machtverschiebungen, Kampf der Kulturen und Globalisierung. Internationale Politik 12/97: 10–20.

Wiegele, Th. (1979) Biopolitics: search for a more human political science. Westview Press: Boulder.

Wimmer, H. (1996) Evolution der Politik. Von der Stammesgesellschaft zur modernen Demokratie. Wiener Universitätsverlag: Wien.

Wolfgang Lipp

The Family: Biological Foundations and Early Cultural Development

A Plead for an Integrated Evolutionary Perspective

Abstract

The family is considered as a "missing link" between culture and nature, representing the product and vice versa—once existing—the vehicle of an evolutionary process. In containing genetically determined "natural" components as well as cultural, "artificial" elements the family opens the view for a nature and culture integrating perspective on evolution. The family serves as the link, mediating within the evolutionary process between prehuman animal hordes and developed, ethnocultural kinship groups, containing transformative processes, e.g., from sex to gender, the "invention of the father" and the process of emerging kinship.

Key words

Evolutionary steps, (human) family, father (hood), gender, kinship, men's (secret) societies, nature–culture.

In CULTURE AND SOCIety, the family may not be the most powerful, yet certainly one of the most important institutions to keep public attention spellbound. This is suggested not only by the "wild", early stages in the history of human development in which the uprise of culture and anthropogenesis go hand in hand with the emergence of the family. Even today, amidst a modern and postmodern culture that seems worlds apart from its preliminary stages, individual lifecourses as well as large-scale collective dramas, "family dramas", indicate that the family (encompassing sexuality, morality, kinship and generations) has remained a deep-rooted and tenacious factor present in everyday human life, in crises and concomitant feverish mythogeneses.

The following essay is an attempt to more closely decipher the connections wherefrom emerges the high sociocultural status, and continuous sociopractical importance, of families. At once, these deliberations form the elements of a book in preparation that will cover the issue in more detail. The starting point is the hypothesis that the rank assumed by the family until today was not merely achieved in the framework of "developments" which were "culturally" codified and represented later-day evolutionary, sociocultural "constructions". Things are more complex in reality. The family consists both of "artificial", cultural aspects and genetically determined, "natural" components—emotions, patterns of behavior and relationships already found in the animal world. Thus, it is necessary to scrutinize the family in terms of natural science—ethnology and sociobiology.

This results in a initial and decisive assessment for this paper: The importance of the family for mankind and society, in life and culture, cannot be systematically conceived by merely taking the family as a serious phenomenon that comprises natural and cultural components alike. At the level of methods, too, it should be consistently argued to approach the family interdisciplinarily and to apply to it complementary perspectives taken from the natural and cultural sciences.

In this endeavor, research should of course not proceed ad hoc. Analysis cannot reasonably alternate at random between one scientific approach and another. Even though the family indeed presents itself as a double phenomenon, encompassing two fields of entity, nature and culture, it has experienced "development" from one of these fields to the other, from one step of existence to the other. The family represents the product—and vice versa: once present, the vehicle—of an "evolutionary" process that joins the spheres while passing through them. Likewise, evolution streams through the world—a

"chaos" of contradictions, tensions and ruptures, that pass into "order"—from the micro- to the macrosphere, from the inorganic to the organic and on to the cultural step. It thus becomes essential to examine the family—the vehicle of man and of the process of anthropogenesis alike (cf. TYRELL 1978; on the connection between the family and "human abilities", cf. KAUFMANN 1990, pp65ff)—in the light of relevant concepts of the theory of evolution.

The following section (Section I) indicates how this may be done more closely in methodical terms. The next section (Section II) presents substantial analytical results, partly with regard to the family's "origins", the "wild", naturally conditioned origins, and then with regard to its early cultural "change". This discussion fails to be comprehensive in view of the limitations set to this paper. We conclude (in Section III) with a novel, fundamental synopsis of the statements that were arrived at, indicating the family to be the very instance to transfer nature into culture and trigger the first culture-generating developments.

I.

Early in time, research is known to have already dealt with the "birth of the family", the path it covered from the unbridled promiscuous "horde", reputed to early man, to the monogamous (e.g., patriarchal, or strictly puritan) form brought forth by civilization. Lewis H. MORGAN (1877/91), Friedrich ENGELS (1884/1972)—or, Johann Jakob BACHOFEN (1861/1975)—and other classics approached these issues in the light of the category of "origin", a complex category, technically sophisticated as much as ideologically corruptible. The origin was then seen as the point from which all that was to emerge was preconstituted in principle. Things were further foreshortened in that the approach was not inter- but intradisciplinary, and thus constricted and blind. With the exception of some thinkers like BACHOFEN, the contemporary perspective of natural sciences was dominant—a perspective which of course veered round to precarious pseudoscientific views without any transition. "Evolution" was seen as a natural, not a cultural process. In view of the enormous, worldview–generating impression that Charles DARWIN and the "Social DARWINIST" Herbert SPENCER had on the zeitgeist, it was biology that chiefly rose to the rank of a model science, or even model ideology. Whenever biology concentrated on the development of man and society—beyond organismic life—it was also leading in formulating questions and eventually produced the decisive, long-valid programs of investigation.

Committed to such traditions, elaborations on "the origin of the family", such as those produced by MORGAN and ENGELS, have of course been discredited meanwhile. In terms of analytical sufficiency, they not only failed to disclose differences between the natural and cultural sides of the processes they investigated—no matter how closely interconnected the issues indeed are. Following a basic mood in the 19th century, they also acted to amalgamate evolution with "progress", in social, cultural and civilizational terms, and aligned it to certain political–moral positions. At any rate referring to one another, references to objects intermerged quite unfiltered with those to value. The results arrived at by the authors had a list and remained in need of clarification.

Since then, research has made considerable progress. It has largely completed knowledge on the family and its genesis—both at a concrete, empirical, substance-related level and a systematic, theoretical level. As to empiricism, it was ethology (together with its human-ethology ramification) and, thereafter, sociobiology that prolifically came to the fore. With a natural-science orientation, they operated closely to biology and particularly adhered to concepts provided by evolutionary biology. From the corresponding side of cultural science, ethnology (cultural anthropology), cultural sociology, parts of women's studies and a set of other disciplines called to be heard. It seems evident that these disciplines would, or should, complement one another: The task was to locate the birth of the family within a "period of transition", a field of "metamorphoses", in which nature was transformed into culture and animal entity into human entity. This issue will be dealt with later in this paper.

Certainly, one obstacle to a potentially satisfactory empirical survey of the family and its early forms is the virtual lack of practical interaction between the disciplines, a kind of cooperation that would decidedly go beyond the barrier separating nature and culture. However, there are also theoretical deficiencies. What is missing—and what would yet need to be taken up—is a sufficiently complex, general theory of evolution, overcoming the nature-culture barrier or rather, more precisely, the insight that theories showing such a scope (e.g., the writings of Rupert RIEDL 1976, 1982, 1985, 1987) are already available in draft form. These concepts would then need to be drawn upon, thematically applied and methodically enriched.

Coming from the natural sciences, then, what needs to be approximated are specifications of the theory of evolution (and Evolutionary Epistemology), such as those produced by RIEDL. And coming from the camp of cultural sciences, likewise, such approaches should be addressed as those provided by General Systems Theory, exceeding individual aspects, and as argued by Ludwig von BERTALANFFY (1949, 1968) and Niklas LUHMANN (esp. 1980ff, 1984).

This is not the forum to present these paradigms in more detail. More importantly, it is a fact that they represent a categorical apparatus that allows to trace system formation (here, the formation of the family system) and evolution as a process that pulsates throughout the world (the world order, the cosmos), its systems and subsystems, through all forms and strata of being. Such pulsation and concomitant structuring are meant to break through the barrier (apparently) maintaining between natural and cultural orders (or the sphere of a "Third World", a world of the "mind", cf. POPPER 1995), as if to "clear" them in "alternating steps" (cf. the sections below on this concept).

System formation and evolution, as present in the continuum of the world and environment, are limited neither to matter (atoms or star clouds), to life (plants or animals), nor to man (e.g., his mind) alongside such cultural achievements as institutions (the family), language or art. They also generate contexts, connections and transitions which develop among the spheres, now organizing processes of "material" energy supply, then directing the systems—and giving them "mental" swing.

As to man, and the human life form of families, it has obviously remained unproductive to seek a methodically bisected approach, "split" into natural and cultural sciences (RIEDL 1985). Quite evidently, man partakes in a multitude of spheres, strata or steps of existence. Body, soul and culture not only overlap in man, crosscut and simultaneously, but they also diverge from him in terms of evolution and the longitudinal section of time. What separations between natural and cultural sciences fail to meet is precisely what stands as central focus in the modern system-theoretically orientated theory of evolution: To decipher the development of man—i.e., from the *Pithecanthropus* and early man to recent man—in terms of a process that runs both in pairs, on one and the other side of the nature–culture barrier, and divergently and that is able to clear the barrier, to converge and nevertheless maintain its direction.

Assuming that current thought in evolution and system theory, claiming the rank of a "supertheory" (LUHMANN 1978, pp9ff; cf. LIPP 1987, p452), indeed provides the most handy instruments for research, the touchstone for such thought will prove to be whether at all or to what extent it is able to lucidly trace the alternating steps performed by man at the nature–culture barrier—that intermediate "biocultural" ("biosocial") area (LOPREATO 1984; cf. FOX 1975). How can one systematically conceive the transition from beast to man, from the object submitted to selection qua nature to the subject, the culture generator himself, performing selection? The first basic studies have become available (cf. WEINGART/MITCHELL/RICHERSON/MAASEN 1997). But where and upon what material will they prove their worth?

The present author's hypothesis is that the modes of such an alternating step can be filtered out once decisively observed in the phenomenon of the early human family. The family is the effect, the instrument and the vehicle of that process, all at the same time. It is the outcome of evolutionary "adaptation" (or perhaps: "hooking") and—as acknowledged post festum—the result of a high degree of "structural affinity" pertaining to complex natural (biosocial) systems (e.g., primate hordes) and to gently emerging cultural formations (e.g., archaic kinship groupings, communities of repast and living units). Accordingly, the family represents the decisive systemic "gearshift" in the transformation of natural to cultural sequences. It rose to be the trigger, or even guarantor, of cultural development in total. It is the "missing link" between nature which man transited and culture which he created—the torque of evolution that made it possible to ascend the steps of evolution.

In the end, the connection is produced by an event that is subsumed under the concept of "coevolution". In terms of system theory, coevolution suggests that systems not only evolve along environmentally given conditions. Rather, the environment is subject to selection that comes to bear on the systems. There are various processes of change and mutual interaction, and constellations of this kind become more consistent the more complexly, the more distinctly and "highly" the units are organized, and the more "momentum" they show—in short, the more they transfer to "self-organization".

As far as the family is concerned, it is assumed to have emerged from the coevolution of natural life (biosocial processes) and constellatorily emergent cultural parameters, such as rituals, barter obliga-

tions or, in short, to have come forth from virtual social norms. According to its inner logic, the process meant that the emphasis of evolution shifted from natural events to the development and furthering of cultural dimensions themselves—in our case, the family. What we are dealing with here can also be called accumulation (of the genetic) into the "epigenetic" (cf. LUMSDEN/WILSON 1983; LUMSDEN 1988), with an open end "upwards", toward the cultural side. By tendency, the vital foundations of the family—life and the given genetic (and/or organismic) constitution of family members (the kinship group)—are accordingly un coupled from the evolutionary process. While emergent cultural forms of being (institutions, traditions and the symbolically codified chains of behavior linked to them) quickly come to the fore throughout and gain ground, man shrinks to be a merely evolutive residue, together with his concrete biological–genetic and/or instinctual equipment. He halts at the developmental level of Paleolithic man, the archaic "hunter" and "gatherer", a dead-weight, torpid and yet vanishing mass.

How can the issues theoretically outlined above be put in concrete and clear, empirically confirmed terms? To raise such questions also means to account for the approaches as well as methods that are available to research and adequate to the issue. How can an object, the specific profile given by an issue, at all be approximated in terms of research technique? What ways and solutions can be found to outline this interdisciplinary project?

This author's position is recounted in a shorthand, suggesting to proceed along a method of "disciplinary double-ways". The first (trivial) objective is to primarily approach natural matter from natural science, and cultural matter from cultural science, with a view on the classical, standard, methodically different instrumentalization of the disciplines. Second, however, the methodical levers can be interchanged and put to use in addition to one another, since the issue—the family and its birth—is located in the transition between nature and culture. For example, the family(group-)like primate (or *Pithecanthropus*) horde would be investigated not only as to what extent it may be described sociobiologically (ethologically), i.e., by natural science, but also as to whether instruments derived from cultural anthropology, ethnology, i.e., the cultural sciences, could be applied. Likewise, the attempt could be made, in reverse, to put natural sciences into operation in forms that are evidently culturally organized, such as the classic matrilineal Iroquois kinship groups in northeastern America. Since the different methodical tools would lead to different technical data, such a procedure would have to be supplemented by a comparison, by dimensional sharpness and a reevaluation of results. The purpose of such a procedure is the chance to render visible, in the object (the family, the birth of the family), the features of natural as well as cultural determinedness, and vice versa: The family emerged in the tension between both nature and culture, its birth is taking place as a transition from one step of existence to another. What matters to research must be to capture the process as completely as possible.

It is suggested that the process did not unfold in terms of a "gradual" development but rather as a "leap" (LIPP 1996), and this leads to a third methodical, methodological observation: Evolution does not go off in a monotonous fashion, without apeces, collapses, partitions or rebeginnings. What is more, evolution allows for "emergences" (cf. LUHMANN 1984 passim; PARSONS 1937 for System Theory and sociology; and C. L. MORGAN 1923 for philosophy), for a more "highly" organized, new "entity" to break through to new "steps of the strata of being" (cf. Nicolai HARTMANN 1940, for philosophy and, based on HARTMANN, LORENZ 1973, for biology and ethology). Research must thus attempt to furnish an adequate, conceptually accurate hypothesis of the process. Konrad LORENZ' choice (1973, p48 et passim) was perhaps not the most conceptually advanced when he referred to "fulgurations" in this connection. But we are in any case dealing with the "flares" and "flashes" of features ever-newly acquired by systems in the evolutionary process, together with technical and formal qualities that accumulate "autopoietically" (MATURANA 1982; LUHMANN 1984), that transfer to take their own course and are intensified in becoming a world of their own. The opinion is widespread that "nature makes no leaps" (Carl von LINNÉ, originally ARISTOTELES). Yet having gained momentum in the natural and other sciences—often unquestioned and by tradition only—this opinion is not, or not implicitly, authorized by nature itself. Indeed, "metamorphoses", changes, breaks and epiphanies of form, can be observed impartially, and not only those taking place when "caterpillars turn into butterflies" (which change their outer form yet remain genetically coherent) but in the very leap from nature to culture: from ape to man, from the horde to the family, and from drives and barking to language and meaning.

Transferring from the natural to the cultural level, evolution decisively rearranges the flows of

function that characterize the systems. For instance, a child's babbling—driven by instincts and feelings—will grow with adulthood and open the horizon of signs, symbols, meanings, and bring about mental connections. Would it be illegitimate to conclude, from this "ontogenetic" finding (the leap from childhood to adulthood), in terms of underlying "phylogenetic" roots urging from *Pithecanthropus* to man? In that case, man would have been dealt the fate of King MIDAS, whether seen as disastrous or not: Everything he touched turned to gold, a destiny studded throughout with symbols—symbolic references and semantic "shimmer". And the leap made here from nature to culture is that a light flared up, with symbols, the use of language, with "meaning" that brightens the scene in all its facets—a light from which no one knowing it can ever return (cf. LEVI-STRAUSS, 1974, p38, relating to J. J. ROUSSEAU: "Language can only have emerged all at once").

In these respects, research now faces the task of tracing leaps of the above kind in a methodically adequate fashion. In classical terms, analysis is furnished with the methods of "comprehension", "hermeneutics" and "interpretation". In concrete terms, and in individual cases, those evolutive sequences of intersection and alternative steps (leaps between levels) are to be brought out of the object, to which the above procedures of cultural science are meant to be applied. For sure, considerable perceptiveness is required in this endeavor. With the example of the family and its genesis, methods of comprehension would need to be shown to become valid and promote cognition in instances in which the use of symbols, ritualization, and the emergence of norms in their embryonic forms can be observed. Interpretation (of certain questionable issues) may be more conclusive in terms of representing a cosmos of new, autopoietically closed, sociocultural systems that regulate meaning and stand out against the level of nature. Should this prove true, it would provide sufficient gainings to research. The cultural leap would then be adequately captured. In parallel, this would have to be put to the test from the other direction, the optics and approach of relevant natural-science procedures. Neither the missing link of the nature–culture transition, nor the evolutive alternating step taken by the family can be identified from one of either sides, the natural or the cultural. The following section attends more closely to the possible evolutive interface that research may address in this connection.

II.

We have now reached Section II of our considerations, a discussion of the most relevant connections regarding our topic, which sets apart two different complexes: First, the family complex as a turntable of the "reproduction" process which biologically conveys man's evolution (including the importance of "sexuality", seen as a compulsive–instinctual component within this event). Second, the family complex as a starting point and substratum of developments regarded by this author in terms of "procreation"—increase of life, creation of existence, and further development in culture. In particular, this paper addresses mechanisms that transform the family and remold it to a "kinship group", seen here as an "artificial", symbolically and culturally "constructed", social community of descent and status. Third, this author will carefully address the issues of "incest taboo", "exogamy", as well as "mothers'", "childrens'" and "fathers'" roles.

1.

A glance at the family's elementary systemic function, which is biosocially and socioculturally fundamental, makes it clear that the early family represents the missing link in human evolution (from animal to man) (cf. for a more recent discussion, TROOST/FILSINGER 1993). In biological terms, life is under continuous pressure to resist "selection" and eradication on the part of the "environment". Life meets the challenges that could endanger it lethally, first, by means of "adaptation"—adapted forms that can offset selection pressure are the ones to survive—and, second and in parallel, by means of increasing "fitness" in the struggle for survival, i.e., high-level "reproductive success" and a progeny increasing by generation.

Lesser organized living things (with the exception of termites, ants and others that form colonies) carry out this struggle in single combat, in isolated, individual confrontation with selective, potential extinctors. When frogs spawn, for example, selection acts doubly to endanger both parents and their offspring. Conversely, more highly organized animals, such as many birds, most mammals, ape and man, are supported by a special evolutionary achievement, the family. In this connection, the family (the "protofamily" in early man, the "familoid" group, "horde" or "subhorde" in animals) not only proves to be the (systemic) site concentrating and clustering the reproductive potencies, activities and opportu-

nities of those involved. Bioscientifically, it also represents the stronghold that ensures the reproductive process based on increasingly balanced collective ("altruistic") efforts (cf. most recently DUGATKIN 1997).

In terms of cultural science, the family emerges as an "institution". As to its technical (sociological) definition (cf. GEHLEN 1956, LIPP 1987/94), it is an institution because it, first, enhances reproduction, including its basic sexual drives, to specifically social levels of organization that are reinforced in group-dynamic terms. Second, the family is an institution in that it specifies family contents directing it with the help of intervening sociocultural norms, values and model ideas. And, third, the family is an institution in that it places reproduction (showing an increasing interconnection with "socia(bi)lization", "enculturation", "personalization", sc. the following generation) on a continuous time base, regulating it beyond individual moments and in alignment with coherence and continuity (cf. CLAESSENS 1962/67, 1973).

The alternating step taken by the family from nature to culture can actually be studied in the light of its basic function to warrant successful reproduction. From the perspective of biology, the development of the family into an ever more complex form and its shift to an autodynamic (self-organizing) sociocultural institution appear to be the mere consequences of an elementary biological mechanism that consists in a long-term dissociation of fitness from direct, external "selective pressure" (CLAESSENS 1973). Here, family rules (such as those of marriage), family rituals (e.g., initiation ceremonies), family roles (mothers', children's and fathers' roles), and finally family functions (caregiving and socialization) are altogether understood, under increasingly complex ecosystemic conditions, as ensuring that progeny and reproductive success is as stable, optimal and autopoietic (or even: "self-selective") as possible (cf. MEYER 1997 on the role played by institutions in the process of evolution). If observed from the other direction, through the eyes of cultural science, there is no denying that the family refers back to biology as far as its origins are concerned. Biology argues that the family progresses to be the turntable of biological reproduction the more complex (organismic) being organizes itself. However, this suggestion would then be reinterpreted and the family shown to act as the "germ cell" (i.e., the "marked form, evolving in life", GOETHE) of all forthcoming sociocultural organization. This perspective evidences that the family represents the root system both of elementary, "genetic" and ramifying (and thereby emergent) "cultural descent": "Lines of succession" have included complex, often bizarre, social "kinship lineages", the development of "tribes", "peoples" and "states", and even the breakthrough of "global society" (which may incidentally owe its existence to a basic "familial ethos", cf. GEHLEN 1969). The family has always been the residual factor and standard for comparison underlying such lines of succession in terms of Evolutionary Biology as well as cultural history (prehistory, early history, time diagnosis).

Complex 1 of my questions should now be interrupted to point out that final results—drawn from more accurate scientific data on the alternating step taken from nature to culture—can only be attained with relevant research that is, at least, doubled in interdisciplinary terms and comparatively investigative. Such conclusions should not be expected here. Likewise, the following brief statements in Complex 2 and 3, concerning the family chiefly as a procreative unit, are to be seen as temporary, merely explorative endeavors.

2.

At once, it now becomes imperative to review the connections. The concept of "procreation" has been introduced above to characterize "creational", specifically "cultural production" (on the basis of innovative "SPENCERIAN selection"; cf. THORNHILL et al. 1997, p209f). Beyond the analogies, transposabilities and alternating steps that generally maintain between "procreation" and "reproduction" (biological reproduction, on the basis of competitive "DARWINIAN selection"; cf. THORNHILL et al. l.c.), it should prove possible to demonstrate the nature–culture correspondences on the basis of individual familial mechanisms—spousal, the incest taboo, etc. Research in (socio)biology, ethnology, cultural anthropology, cultural history and other disciplines has summarized the issues with the concept of "kinship", along with its various forms. This concept remains in focus in the following considerations.

Let us first concentrate on "spousal". The German word, "Gattenschaft", implies a double relationship, the fact that spouses (can) enter into a reproductive relationship partly in biological terms ("copulation") and partly in cultural terms, in the sense of "marriage" (promises of marriage) and/or on the basis of certain rituals, rules and ideas of values. In English, the phenomena are precisely differentiated in everyday speech, and even more so in scientific lan-

guage. "Sex" refers to elementary biological (instinctual, driven) processes, while "gender" refers to the intermeshed, institutional and cultural moments overarching sex (cf. ORTNER/WHITEHEAD 1981). Marking quite different issues, the concepts should indeed be strictly set apart in analysis. Copulation and sex may lead to conception, pregnancy and children, they serve to establish permanent social bonds and stable patterns of descent: in short, the forms and functions of the family. Anthropogenesis becomes possible in the first place, "human abilities" (KAUFMANN 1990) are accumulated, and higher sociocultural competencies are mediated through these forms and functions—yet not eo ipso. The process of copulation, a (merely) "natural event", must first be complemented with the regulation of gender—the order and allocation of "genders" themselves, the establishment of "lines of succession", and the construction of "kinship lineages". And this complementation is indeed marked, as emphasized by research, by artificiality (cf. in more detail LIPP 1986/94 with the example of "shifting gender roles"). It is enacted in the framework of sharpened, highly dramatic ritual performances, while normatively directing the motives of those involved, their bonds and interests, even up to a "reversal of driving direction" (GEHLEN 1956, p266).

Still, the connection does have another side: sex and gender correspond and seem to have approximated one another, or even mixed, in the early phases of human development. LOVEJOY (1981), FISHER (1982) and other writers, for example, indicate that the appearance of man—such advanced, further-reaching hominization as was present or became possible at the *australopithecine* level—was closely connected with a change in early man's sexual disposition. It seems as if the *australopithecine* woman's transition from manifest, e.g., olfactorily perceptible, to latent or covert forms of ovulation (female physiological conceptability) were responsible for this important behavioral leap in evolution, which was to make possible genuinely cultural ties. Not only was the dissociation of rutting and mating seasons from copulation in the offing. With increasingly permanent sexual stimulation, which began to bind men to women, the relationships into which the two entered were enriched in progressively complex technical-social respects. Women realized that men who lured them not only sought (sexual) satisfaction but also paid tokens and did favors, sharing their bag, ensuring protection and providing food for them and their offspring. Following speculative conclusions, particularly those in FISHER, the process may have resulted in that women and their living environments as such (children, infant care and provisions, communities of sleep and repast, the "camp" or the "nest" in general) became more and more attractive to men. According to FISHER, the constellation finally veered round. The new system then joining men, women and children proved to be most successful in evolutionary terms. It generated fitness and survival benefits not only in a closer biological sense, but it acted procreatively and enabled genuinely moral and cultural categories to emerge: esteem for women beyond momentary sexual attraction; acceptance of children and thus of fatherhood; shared obligations in child care; even male "domestication" in general, male integration into a common "home" (cf. esp. LAFONTAINE 1981). But does this development already point out to the emergence of monogamy, the "classical" form of marriage that has since been in high esteem, on the basis of paleontological marks such as those left millennia ago by Lucy, the female *australopithecine* and "model fossil" (cf. most recently JOHANSON/BLAKE 1996/98)? This is what Helen FISHER would suggest, yet such suppositions should perhaps not be given too directly.

3.

Following the premises of a methodical double-way, let us now shift our perspective once again. How can the transition (the leap) be reconstructed from reproduction to procreation—from "wild" prehuman behavior to "tame" human behavior—on the basis of natural disposition as well as autopoietically emergent cultural mechanisms? What happens to (human) nature when it gets caught in the maelstrom of culture, a more complex systemic level of existence structured along possibilities? Let us first take a look at the example of the processual turntable, the cardinal gearshift "family", and the phenomenon of familial "gender roles".

As explained by science, such "roles", standardized cultural schemes of behavior, did not develop between men and women in a uniform, balanced fashion. The status of males and females in the reproductive process were not entirely clear to archaic mind and were obviously judged differentially. Achievements and qualities that were identifiable with women in the protofamily (birthgiving, nursing and child care) must have been immediately evident, so that women's reproductive performance hardly needed an additional cultural profile—the development of a special "maternal" role (cf. GOUGH

1971; ORTNER 1972). However, the status assumed by men in the system originally remained covert and uncertain (cf. READ 1918; MALINOWSKI 1922/79, and more recently MÜLLER 1984). It was difficult for early man to make out temporal connections between sexual copulation, perceptible female conception and the birth of children to specific men and women. Affiliations were also undecided in technical terms: Women and the children they brought forth represented "one blood" and were bound by "blood relationship" (FOX 1967; TYRELL 1978). On the other hand, the male side was basically an unanswered question: Mater certa, pater semper incertus est. Of course, there was no need in archaic days to determine purely biological paternity according to today's definition and as rooted in society and culture, e.g., in maintenance legislation. A general need was felt, however, to reliably cooperate with cospecific individuals (women and children) in order to guarantee life and survival. Not least for this and other economic reasons, men were increasingly keen on claiming their authorship, competence, in short: their special familial "role" vis-à-vis groups of mothers and children who promised "prospects for the future".

By "analogy", the cultural level allowed to create what failed to appear conclusive "by nature" (immediate to life, to all appearances) by means of rites, rules and symbols: the integration of the male into the family—a family that structured itself in a system of family roles. As to men's role, differences were to be made between "spouses" and "fathers". According to the perspective of (socio)biology (cf. e.g., B. MEYER 1982), reproduction takes place as a competition (between men, resp. sperm cells) for the "scarce good" women. Assuming sexual dimorphism, men then basically competed with one another for women within the process of reproduction. Raising the process to the cultural level, it follows that the access to this good must be limited, regulated and "licensed" (socially authorized). "Spousal", a spouse's status or the license to copulate, cannot be drawn upon at random—neither biologically, along the lines of natural conditions, nor culturally, along symbolic determinations. It is not made available without limits, commitment nor loss. Its allocation is always selective and enacted in the framework of selective cultural "rituals" that are marked by taboos, asceticisms and trances.

Rituals—primarily fertility cults, initiation ceremonies, stagings of birth and rebirth—have the function in cultural life to render "meaning" to existence (cf. BÜHL 1982; VESTER 1986). They give new meaning that is practical to life, especially in the sphere of "crises", the insecurities, danger and horror as brought along by unknown (unregulated), future circumstances (cf. for more details LIPP 1997b, pp216f). By rule, their addressees (boys and young men in this case) gather sustainable social experience that proves as shattering in psycho–physical terms as it is character-forming: the change of status from "childhood" to "adulthood". In the end, they enter into the new, specific rank of being "mature men", licensed to being "husbands", and assume their "roles" of "spouses" in "families" (their "procreative" and/or "conjugal families").

Again, the fact of being sexual partners, the potential to become mothers and bear children, was evident in women "by nature". But this had yet to be extended to men "in accordance" and translated into culture: Women appeared to be "born" to be women (and mothers etc.), and men "made" to be men (spouses, fathers) in cultural–symbolic terms. Such "rebirth", the process of men assuming a new, culturally defined "identity" and adopting distinctively male gender roles, was said to show the features of a "forging process" (POOLE 1982). Ritual fires acted to anneal, hammer and bend into shape the natural aptitudes and sexual drives to be "molten" in men. While fertility rituals and initiation ceremonies were performed for women (girls) in a lessened form, i.e., to reflect male rituals (cf. THURNWALD 1932, pp52ff), they intervened into men's life more directly and more selectively. Exceeding the creation of "spouse" roles, they led to the establishment and specific cultural reinforcement of "fathers'" roles.

"It's easier to become a father" in biological terms, says the proverb. "To be a father" in cultural terms, however, represents a complicated, morally interpreted (or interpretable) social status (e.g., the liability to provide maintenance). It now seems necessary to sketch the connected determinations more precisely:

The "father" status is subordinate to that of "spouses" in that only the latter can enable the former to develop. No matter how the allocations proceed biogenetically, they long remain obscure as such. Once it is (ritually) clarified which men are given as spouses to which women, can children born from women be allocated to certain "fathers". In other words, only once men and women are bound in spousals—once they have concluded "alliances" (LEVI-STRAUSS 1949/81, chap. viii), wedlock, matrimonial agreements on a simultaneous horizontal basis—can their relationships to children (grandchildren, etc.) be regulated in vertical, time-shifted

terms, in terms of "descent", in a "filiative" lineage, and in terms of "cultural descent", "genders" and "kinship".

The role of spouses clearly precedes that of fathers. Although it is of prime importance to the development of kinship systems, the role of fathers is additionally concealed by the fact that it faces the enormous reproductive weight given in life to "mothers" (or to "mothers' roles" at the procreative level). The decisive cultural condition in the development of kinship systems is the question as to whom of the alliance partners (the male or female partner, or both) the children issued from their marriage should be "entrusted" to, e.g., as valuable assistants and coworkers in the struggle for survival. Given this issue, allocation certainly could turn out to be one-sided and concentrate on women (physical mothers). This latter, more original case applies to the development of one-sided "matrilineal" kinship systems (such as the extreme case of the Indian Nayars). Conversely, "patrilineal" patterns evolved in the case of allocation to men, the cultural fathers (most extremely in traditional China). However, similarities emerged in the kinship structure: Everywhere, from the past to the present, "fathers" were the ones to give to human descent and the filiation of progeny the sufficient extent of cultural selectivity: Even in cases of matrilineally organized kinship (that can fall back upon "natural" evidence of "blood relationship"), the fathers structurally convey, semantically codify and symbolically justify the allocation of children to "mothers" (and/or daughters and daughters' daughters)—i.e., certain (namable) mothers who have certain (namable) spouses.

Yet upon investigation, the individual connections prove to be extensively interlocked. Ethnological research has evidenced (cf. THURNWALD 1932; MURDOCK 1949, 1957; LEVI-STRAUSS 1949/81; MÜLLER 1984) that kinship systems often adopt peculiar and multivariate plural forms, from simple "nuclear family" structures to large "tribes", "clans" and "kinship federations". Of course, we prefer for the time being to leave this discussion to ethnology (cf. most recently KRAUS 1997 in conceptual systemic terms) and turn to the immediate phenomenon of "incest taboo", a strategic mechanism in our issue.

The incest taboo, a strong, biologically plausible, intrafamilial barrier to copulation, is precisely the site from which familial and thus explicit cultural forms of existence start. "Prohibition of incest is the procedure with which nature overcomes itself; it is the spark that gives rise to a new and more complex structure, superposing and integrating the simpler structures of psychic life, as these in turn superpose and integrate the yet simpler structures of animal life. It bears and is itself the arrival of a new order" (LEVI-STRAUSS 1949/81, p74; my translation). How can the relationship between reproductive and procreative factors be elucidated in this connection in terms of the theory of evolution? The following is again given in keywords.

It is known that man—along with many kinds of animals—has an aversion to permit sexual intercourse and copulation between parents and children (and among siblings). Anchored in animals in terms partly of instinct (biogenetically), partly of inprinting, partly of habit, such repugnance is additionally supported in man by taboos, i.e., fastening and genuinely cultural norms. Applying to both such cases, a uniform biological foundation complies with the elementary rule of biological reproduction according to which the largest possible genetic variety is to be ensured in the reproductive process. This foundation checks losses of fitness by means of barriers drawn up against incest (inbreeding) (cf. esp. BISCHOF 1985).

It is plausible, and no longer disputed in present-day research, that the incest taboos practiced by man (prohibition in the sense of generally valid cultural norms, together with all typical exceptions) refer back to the above biological mechanisms (cf. BISCHOF 1985). At once, incest taboos bring along another achievement in culture and society, which fastens into and yet leaps across their original biological function. As shown convincingly by LEVI-STRAUSS, incest taboos not only show the effect of prohibiting inbreeding, or "endogamy" at the cultural level (and in cultural–anthropological, ethnological terms). Beyond the negative side (of prohibition) such taboos unfold a positive, constructive, procreative influence to regulate "exogamy". Incest taboos prohibited copulation in the primary group (protofamily, horde or subhorde) to the very same extent that they also became a precept stipulating exogamy, i.e., "marrying out". They acted to generate a norm from copulation (or spousal in more precise terms of cultural logic) with partners coming from external (alien) familial (protofamilial) groups. Incest taboos amount to settlements of matrimonial agreements between these groups, showing sociogenic features and allowing for ever denser social networks.

LEVI-STRAUSS identified the system of "bartering women" as the mechanism that summarizes and embraces the sociocultural regulations discussed here. Similarly, Max WEBER (1921/64, pp283, 328, 514) had already referred to the "exchange of

women" and "bartering cartels". This paper will not go into more details of this phenomenon. In theory, however, the exchange of women (and "exchange" in general) is undoubtedly one of the most productive sociocultural categories. Exceeding its closer economic connotations, exchange is to be understood in quite basic terms (as elucidated by its deeper-lying strata of meaning: "interaction", "reciprocity" or "mutuality")—as "surmounting borders", as a Hermes-like "messenger of the gods" clearing the spheres (resp. steps) of being. Moreover, there is no contradiction in seeing original exchange, in terms of cultural evolution, as bartering women, an exchange of basic biotic potencies. Instead, the change of perspectives leads back to the initial phase—the world of prehuman, "wild" life that had not yet been "domesticated". The principle mentioned above, according to which women represented a "scarce" reproductive "good" that could only become available in competition, helps explain why women, not men, became the passive object of barter. Men took over the active part in reproductive events which presented themselves as struggle for predominance, i.e., for priority copulative access, over "competitors". "Copulation bonuses" were awarded by women, the execution of "selective breeding" in the strict sense of biological reproduction, but men increasingly assumed direct control of the process. The result can even be calculated (cf. TRIVERS 1978), and the process itself was amplified when men no longer exclusively competed as individuals but joined forces to form "coalitions" (cf. the summary in DUGATKIN 1997, pp125ff) or pacts that negotiated the "use" of women (their reproductive potential) as a run-up. Research has provided sufficient evidence that such regulations are not limited to (early) man—baboons are equally capable of such negotiations (cf. PACKER 1977; DE WAAL 1997, pp236ff). There, women can also move into rather passive positions dependent on men (also cf. PAUL 1998, p17). Let us return to the phenomenon of incest taboo. What was to be clarified with this issue? In view of the abundant questions that could arise in this connection, my answer must remain brief:

In the perspective of the theory of evolution, the incest taboo has a double function for the family: First, it makes it possible to more precisely distinguish between families (basic units of procreative (cultural) processes) and hordes (the familoid, pre- and early human units of reproduction). Second, it indicates that and how families, now appearing in their "nuclear family" form (spouses with their child or children), are embedded in "kinship" and/or expand into kinship. These two functions are crucially based on the transformation of copulation, as practiced by horde members, into the alliances (spouse relationships) entered into by members of different (mutually external) families (familoid groups, hordes, subhordes). Now, how can this process be conceived beyond LEVI-STRAUSS' basic outlines?

Robin FOX has indicated (1975; in terms of social anthropology and sociobiology) that alliance and filiation (descent), the crucial structural preconditions of the human family, can be found in such animal populations as higher-developed apes. In this example, however, alliance and filiation appear as separate, mutual independent, only "familoid" organizational forms: "One-male groups" consist of dominant, harem-holding males (e.g., the Indian langurs, cf. SOMMER 1996); "multi-male groups" are those in which males principally have (hierarchically ordered) access to all females (e.g., chimpanzees). In humans, and only in humans, however, do families enter into closer inner bonds. Alliance, the licensing and social (dominative) establishment of copulation, is clearly developed in apes' one-male groups, yet not descent, breaking off from harem lord to harem lord and finally dying out. Conversely, sustainable filiative patterns become apparent in multi-male groups (specific, stabilized lines of descent centered around women or mothers), albeit lacking permanent, exclusive spouse relationships. In both cases, the groups fulfill their basic biological function to maintain the species (resp. certain gene pools) to a nearly equivalent extent. But they obviously fail to exceed the level of mere (natural) reproduction. Only man has been able—in my reading of FOX—to join alliance and filiation, spousal and descent (kinship) into a new uniform type of constellation. The family was to emerge as a typically human, cultural institution. It came in to leap levels, to take a systemic alternating step, and to release new, procreative developments.

As made plausible above, the incest taboo served as agent of the process and as central mediator, together with the exchange of women. The latter should not merely be considered a method with which men took possession of women. Rather, exchange of women was decisive in that it brought the family beyond the elementary form of nuclear families, expanding it to become the sustainable social system of "kinship". Alliances between men and women, spouses, mothers and fathers (and adjectively, solidarity between children and siblings) were culturally established and made permanent. But in

view of the limited procreative capacity available to nuclear families (qua nuclear families), this process would not have been feasible without the extensive stabilizing effect of kinship that generated mutual obligations. Kinship, the organization of relationship systems, and the unfolding of these systems thus proved to be the way leading beyond the earliest familial origins and raising man and society to a long-lasting cultural level.

III.

The notes delivered so far on this issue now come to an end. The following will focus the main viewpoints to results.

Our topic was the "nature" of the "family"—a nature that showed to be natural and cultural at once, and a nature thought to be adequately conceivable from its "origins", the archaic developmental phases of the family. In order to locate an object in its origins, a reconstruction of its conditions of being, its genesis, is necessary. The integrated approach drawn upon in this essay, deriving from the theories of evolution and systems, claims strategically to avoid the often reproached mistake of "reductionism". Research into origins is often rebuked of such a reductionistic approach, applying to retrogression to the indifferently, primitively old and simple, the ever same. To elucidate conditions of being and generative connections does not mean to locate them "gradualistically", in the infinitesimal sequence. Rather, these conditions and connections should be brought into connection with emergence, "leaping" new qualities, the "leap" phenomenon. Origins indeed represent leaps: they are even methodologically to be dealt with as a series of steps, alternating rhythm, tension and speed but not necessarily changing evolutionary direction.

This is the present author's maxim in regard to the procedure. But what can be said about the issue in question?

In accordance with our initial hypothesis, the change from nature to culture, from (biological) reproduction (and corresponding fitness strategies) to (cultural) procreativity, runs over the gearshift of the family. The family serves as the link and "headquarters" mediating within the evolutionary process between prehuman animal hordes and developed, ethnocultural kinship groups. Little investigated in this respect, the family represents the missing link for every sophisticated theory of evolution that aims at interdisciplinary integration—a missing link that allows to systematically structure, disclose and investigate the transitions in question, together with the modes of such transitions.

Starting out from these assumptions, several seemingly important transformative processes have been analyzed in more detail: first, the process of sex–to–gender transformation; second, the processual invention of fathers; and third, the process of emerging kinship and kinship systems. The following outlook addresses the borders set to these systems, their decline and the rise of new structural and cultural forces operating beyond the family and kinship—the development of men`s (secret) societies. The statements are summarized as follows:

Firstly, the transition from sex to gender, from biological–sexual to cultural gender, did not take place ad libitum. The relationship between sex and gender is one of correspondence, at least with regard to early cultural development. The "leap" occurring in this connection does not imply that gender systems represented mere, sex-free "constructs", fully removed from their biological foundations, or even from substantiality and materiality. Instead, the leap suggests that man gave a name to his drives, relationships and bonds, classifying and rendering significance to them—a specific, life-influencing sociocultural "meaning".

Once the, say, "symbolization" of gender had commenced, transformation processes became increasingly entelechial and self-organizing. Sexual energies were deflected, regulated and sublimed in the sense of emergent, distinct "gender roles" (spouses, father and mother, daughter and son, siblings). They were given a new (autopoietic) expression, a new (procreative) weight within "kinship" and "kinship systems" (of varying degrees of complexity). It is not difficult to see that cultural norms, rites and institutions set the tone with regard to such energies—together with their specific "systemic codes" and "guiding ideas"—rather than genes, instincts or drives. Alternately, GEHLEN's "reversal of motivational direction" would take place in borderline cases.

To all appearances, and along with the genders themselves, typical asymmetries gained ground within the relationship: The shares brought in by nature and culture into the rising cultural gender constructs did not vary at random. Most myths, taboos and normative prescriptions in (ethnocultural) circulation to interpret and self-interpret gender (role) identities show larger shares of nature in female than in male gender life and, likewise, larger cultural ones in men than in women (cf. ORTNER 1972, and also MÜLLER 1984). Yet, for sure, to formu-

late such ascertainments does not necessitate testimonies as to substance (concerning men's and women's "nature in general"). In terms of (cultural) self-interpretation, however, men and women developed divergent images of the extent of natural shares which they "bore to the full term". This suggests that precisely those shares of nature have remained essential in gender life, a transverse, unwieldy factor to finally burst the systems. "Is female to male as nature is to culture?" (ORTNER 1972)—this question cannot simply be answered in the affirmative or negative, but it certainly makes clear, with the very example of gender (gender roles, kinship), that different factors were indeed operative. This question should evoke ways to research how the concepts interlock, evolutionarily and in concrete terms.

Secondly, what precise changes have sex and gender undergone in the course of the development of the family? Where and in what closer sphere of gender roles did the crucial biocultural transitions take place? What in fact brought about the birth of the family, and what was the essence of its specific leap?

The author argues that the "invention of the father", i.e., of man in a father's role, was what set the things in motion. Mother–child dyads (in a potential daughter–daughter filiation) were the core elements to accompany the formation of families (from prehuman familoid to human familial groupings). Yet only the integration of fathers initiated the system to be cultivated (cf. FOX 1967, esp. pp39ff, who gives the process no explicit liminal value in terms of cultural evolution.). On account of prolonged "brood care" phases, amongst others, mothers and their children obviously were a seed crystal for social attention, care and community formation (e.g., communities of repast) within prehuman survival. But they only expanded to become families (i.e., normatively regulated, institutionally continual communities of descent, solidarity and cooperation) on account of (ritual) dispositions by which males were given the (ritual) status of "fathers". In other words, only at this very point could the accumulation of reproductive power, embodied and administered by the family, be fulguratively vented, be raised to the level of procreation, and continue its creative development.

It is difficult to overlook that the role of the father is closely connected to that of the spouse—the cultural licensee of spousal, marriage and its consummation. Complementarily presupposing one another, the schemes can hardly be isolated. At the same time, the father role assumes a decisive rank within the "family system". This role is the one to ensure that families represent stable, intergenerational associations that are namable in their allocations. They alone guarantee lines of descent and kinship that include males in addition to women (mothers) and children.

The fact that fathers are here given structural weight also applies to the phenomenon of bartering with women. As already stated, such exchange had a sociogenic effect. It enabled man to overcome the tight circle of the protohorde (subhorde), to establish interfamilial (kinship) relationships, and start to structure complex, evolutionarily more advanced social forms. The said function was by no means limited to early human phases of development. It continued to have an effect upon the most recent political matrimonial pacts in European history ("tu felix Austria nube"). The late Austrian example still indicates that the exchange of women not only allowed elementary reproductive potencies to be bartered. In addition, procreative, cultural forces were released: The exchange of women underlined and activated economic ties and proved capable of bringing about peace at the political level, while expanding social interaction in general and generating new, overarching, ritual–religious bonds.

At any rate, the exchange of women (of "daughters", as evidenced by LEVI-STRAUSS) strategically refers back to culturally defined "fathers". When fathers were missing, there was also a lack of daughters. And in such lack, (reproductive) goods worthwhile of procreative barter were also deficient—with a view upon enhancing (emergent) sociocultural values (e.g., prosperity, peace, security). Only fathers, together with the ritual and institutional establishment and molding of "fathers' roles", acted to ensure that the exchange of women acquired a more refined, practically more complex, cultural significance and selectivity. Johann Jakob BACHOFEN (1861/1975) has remained directive in this respect: His was a sensitive view, derived from classical studies and struggling with the contemporary Zeitgeist, on women's honorable "matrimonial" status in early (pre-Antiquity) stages of culture. Yet BACHOFEN left no doubt in the end that culture truly began with "fathers", the "invention of fathers". According to that writer, the cultural principle of "mind" only asserted itself with fathers, gained the upper hand over the maternal principle of "matter", and then facilitated more emancipated (more tense and dramatic) sociocultural development.

Let us now refer to another classic, Sigmund FREUD, the founder of psychoanalysis, in order to fur-

ther intensify the issue. Our conclusions have evidently brought us into contrast with FREUD, a contrast that must be recorded: The change from hordes to families, the breakthrough of self-contemplation, senses of guilt and morals, the leap from nature to culture, was not made possible by "killing" the father, as performed by his sons (so depicted in "Totem and Taboo", FREUD 1913). The leap did not take place by eliminating the father. Rather, it was the fact that he was ingeniously created to be the vehicle of the father role and that he and his role were integrated, classified and anchored in the new, concomitantly developing cultural system of family.

The issue on hand gains yet additional momentum with a perspective drawing on Georg SIMMEL, the sociological classic. According to that thinker (1908), social constructs are not least characterized by their specific "quantitative determination". Two-person relationships, couples, only develop into transpsychic, actual social systems, passing into self-operation, once a third party is introduced to make possible power coalitions, hierarchies, establishments (institutionalizations) in action. In fact, families adopted a cultural form in the original evolutionary field of transition by the procreative expansion of mother–child dyads (in daughter–daughter lineages), as were present in hordes, with the integration of men (spouses) to be fathers. The process required originally "wild" men to be culturally (ritually) "domesticated" and become fathers (LAFONTAINE 1981). The consequence was that women and children were also given a new status and procreative meaning. With the invention of fathers, the family itself was born.

Thirdly, it has been sufficiently demonstrated that the family and kinship mutually presuppose and prerequire one another in terms of cultural logic. This point needs no further elaboration. The family is virtually encapsulated in kinship which in turn combines families (hordes, subhordes) that barter or once bartered (through the exchange of women) and thus created alliances along the lines of specific filiative patterns. Against this background, the question can be addressed as to whether and to what extent families, no matter how different they may be in structure, contain an inner-most core—a "nucleus"—that is "universally" present and globally valid. Research has dealt with this question in quite controversial terms (cf. the uncertain position in FOX 1967, pp39ff), and Rolf EICKELPASCH (1974), for one, firmly disputes universality in connection with the nuclear family. However, the considerations brought forth in this essay have argued that the family and kinship, regardless of their complex forms, are based on the linking scheme of the nuclear family. The nuclear family represents the elementary cultural (and biocultural) bond allocating and connecting spouses, parents and children (siblings) to one another—as already postulated by Claude LEVI-STRAUSS (1949/1981, most recently 1986/1996; in ethnological–structuralistic terms), George MURDOCK (1949; in social anthropological terms) or Talcott PARSONS (1954/1964; in sociological system-theoretical terms). Substitutes of a trivial or alternately ritual kind have included certain ceremonial spouses, step-parents and adoptive children. Such substitutes have served to mend and reconstitute the nuclear family in cases of factual (or apparent) spouse, parent or child deficiency due to death, miscarriage or external family-structure constructions. And in whatever cases the nuclear family "dissolves" or appears to do so (in the sense of "deinstitutionalization", such as in families living apart and yet together, patchwork families, gay and lesbian groups in postmodern culture, etc.; cf. TYRELL 1988), the structural deficits also affect adjacent chains of action (e.g., socialization, personalization)—which finally begin to skid.

Yet there is a counterpoint operating against the family, the nuclear family and kinship. Cultural evolution did not or could not content itself with creating sociocultural systems organized along the lines of kinship. Organizational forms that were based on gender models showed an ephemeral and deficient degree of functional, internal complexity. In the course of their development, such forms failed to address the set-up of strategies aiming at more rational and practical control. The reason was that these forms were limited to solutions regulating all sorts of problems according to competencies which in turn were linked to kinship and kinship roles. These forms of organization thus lost verve and found themselves entangled in familism, nepotism, gender concoctions and other struggles. Together with their control mechanisms, kinship systems that once had lifted man from the level of nature to that of culture began to unfold an restrictive impact on evolution. They enveloped society's body like a corset, a serpent's skin that had become too tight.

Men's (secret) societies finally proved to be the very counterpoint from which things were again set in motion. This essay can only deal with them in cursory terms (cf. more details in LIPP 1990/1994, 1997a). With regard to evolution, men's (secret) societies developed relatively early, structurally identical to and paralleling the birth of the family itself.

They represented the product (or a by-product) of fertility cults, initiation rites and ceremonies through which young men, temporarily joined in male groups and comradeships assembling men's houses, were forged to become spouses and fathers. At this decisive bifurcation in cultural evolution, however, men's (secret societies) pursued a new, autonomous course and developed into structures that finally conflicted with the family and kinship.

But whatever familial motives were maintained in men's (secret) societies certainly remained important enough: the atmosphere, the motive and value of "brotherliness". Brotherliness then virtually gained the new transfamilial quality of "sworn", "communitarian" proximity. It became the model for deeper-reaching experiences of "solidarity", acted to discover the principle of "equality" and introduced "liberty" into cultural history—the endeavor, not to integrate into, but to bypass families.

At least in basic terms, the status now assumed by men's (secret) societies has become clear in society and culture, the economy and politics, in everyday life as well as in states of emergency. Men's (secret) societies accelerated the development and expanded kinship and kinship associations into tribes, phratries and entire peoples. They established domination and constructed states, triggered martial affairs as much as economic endeavors, technical and scientific projects. Men's (secret) societies founded orders and churches and called for crusades.

Although born from the same womb, fraternities indeed represented a counterpoint to the family and kinship. Equipped with new, more mobile means, they were again to set afloat the process of evolution that had started off with the birth of the family and then faced the eye of a needle in familism. All the more clearly, then, should the high and lasting (albeit now covert) achievement of man become visible in retrospect—the act of overcoming the barrier of nature and launching himself and his equals to become a family.

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References

Bachofen, J. J. (1861/1975) Das Mutterrecht. Eine Untersuchung über die Gynaikokratie der alten Welt nach ihrer religiösen und rechtlichen Natur. Stuttgart. (New edition edited by H.-J. Heinrichs. Frankfurt/M. 1975).

Bertalanffy, L. von (1949) Das biologische Weltbild. Die Stellung des Lebens in Natur und Wissnschaft. Vol. 1. Bern.

Bertalanffy, L. von (1968) General System Theory. Foundations, Development, Application. New York.

Bischof, N. (1985) Das Rätsel Ödipus. Die biologische Wurzel des Urkonflikts um Intimität und Autonomie. Munich.

Bühl, W. L. (1982) Struktur und Dynamik des menschlichen Sozialverhaltens. Tübingen.

Claessens, D. (1962/67) Familie und Wertsystem. Eine Studie zur "zweiten soziokulturellen Geburt" des Menschen und zur Belastbarkeit der "Kernfamilie". Berlin. (3rd revised and expanded edition 1967).

Claessens, D. (1973) Anthropologische Voraussetzungen einer Theorie der Sozialisation. Zeitschrift für Soziologie 2 (3): 145–162.

Dugatkin, L. A. (1997) Cooperation Among Animals. An Evolutionary Perspective. New York, Oxford.

Eickelpasch, R. (1974) Ist die Kernfamilie universal? Zeitschrift für Soziologie 3: 323–338.

Engels, F. (1884/1972) Der Ursprung der Familie, des Privateigentums und des Staates. In: Marx, K./Engels, F. Werke (MEW). Berlin (East), vol. 21 (1972), 25–173.

Fisher, H. (1982) The Sex Contract. The Evolution of Human Behavior. London.

Fox, R. (1967) Kinship and Marriage. An Anthropological Perspective. Harmondsworth.

Fox, R. (1975) Primate Kin and Human Kinship. In: Fox, R. (ed) Biosocial Anthropology. London, pp. 9–35.

Freud, S. (1913) Totem und Tabu. Einige Übereinstimmungen im Seelenleben der Wilden und der Neurotiker. Leipzig, Vienna, Zurich.

Gehlen, A. (1956) Urmensch und Spätkultur. Philosophische Ergebnisse und Aussagen. Bonn.

Gehlen, A. (1969) Moral und Hypermoral. Eine pluralistische Ethik. Frankfurt/M.

Gough, K. (1971) The Origin of the Family. Journal of Marriage and the Family 33: 760–770.

Hartmann, N. (1940) Der Aufbau der realen Welt. Grundriß der allgemeinen Kategorienlehre. Berlin (3rd edition 1994)

Johanson, D./Blake, E. (1996/98) Lucy und ihre Kinder (Engl. original 1996). Heidelberg, Berlin 1998.

Kaufmann, F.-X. (1990) Zukunft der Familie. Stabilität, Stabilitätsrisiken und Wandel der familiären Lebensformen sowie ihre gesellschaftlichen und politischen Bedingungen. Munich.

Kraus, W. (1997) Zum Begriff der Deszendenz. Ein selektiver Überblick. Anthropos 92: 139–163.

LaFontaine, J. S. (1981) The Domestication of the Savage Male. Man, n.s., 16: 333–349.

Levi-Strauss, C. (1949/81) Les Structures élémentaires de la parenté. Paris. (German: Die elementaren Strukturen der Verwandtschaft. Frankfurt/M. 1981).

Levi-Strauss, C. (1986/96) Vorwort zu: Altertum (= Geschichte der Familie, edited by A. Burguière et al., vol. 1. French original 1986). Frankfurt/M., New York, pp. 9–15.

Lipp, W. (1986/94) Geschlechtsrollenwechsel. Formen und Funktionen, am Beispiel ethnographischer Materialien. Kölner Zeitschrift für Soziologie und Sozialpsychologie 38

(3) (Focus issue "Wandel von Geschlechtsrollenbeziehungen", edited by Schöps-Potthoff, M./Tyrell, H.): 529–559. Reprinted in: Lipp, W. (1994), pp. 308–345.

Lipp, W. (1987) Autopoiesis biologisch, Autopoiesis soziologisch. Wohin führt Luhmanns Paradigmenwechsel? Kölner Zeitschrift für Soziologie und Sozialpsychologie 39: 452–470.

Lipp, W. (1987/94) Institution. In: Herzog, R. et al. (eds) Evangelisches Staatslexikon, vol. 1, 3rd edition Stuttgart, col. 1344–1351. Reprinted in Lipp, W. (1994), pp. 375–382.

Lipp, W. (1990/94) Männerbünde, Frauen und Charisma. Geschlechterdrama im Kulturprozeß. In: Völger, G./Welck, K. von (eds) Männerbünde, Männerbande. Zur Rolle des Mannes im Kulturvergleich, vol. 1. Cologne, pp. 31–40, 343–344. Reprinted in: Lipp 1994, 291–307.

Lipp, W. (1994) Drama Kultur. Teil 1: Abhandlungen zur Kulturtheorie. Teil 2: Urkulturen—Institutionen heute—Kulturpolitik. Berlin.

Lipp, W. (1996) Natur-Kultur-Übergänge: Stetigkeiten, Brüche, Sprünge? Was erklären die "Institutionen" und wie erklärt man sie selbst? Worin Claessens Gehlen folgt, wo er sich von ihm unterscheidet und warum er die Institutionen verkennt. Ethik und Sozialwissenschaften 7: 390–393.

Lipp, W. (1997a) Männerbünde: Geschlechterordnung und Kulturfortschritt. In: Deutsch, W./Walcher, M. (eds) Sommerakademie Volkskultur 1995/96: Ordnungen, Spiele. Vienna, pp. 127–132.

Lipp, W. (1997b) Nehmen, geben, opfern. Was heißt opfern soziologisch? Oder: "Macht Zivilisation das Opfer überflüssig?" In: Gabriel, K./Herlth, A./Strohmeier, K. P. (eds) Modernität und Solidarität. Für Franz-Xaxer Kaufmann. Freiburg, Basel, Vienna, pp. 213–227.

Lopreato, J. (1984) Human Nature and Biocultural Evolution. Boston, London, Sydney.

Lorenz, K. (1973) Die Rückseite des Spiegels. Versuch einer Naturgeschichte menschlichen Erkennens. Munich, Zurich.

Lovejoy, G. O. (1981) The Origin of Man. Science 211: 341–350.

Luhmann, N. (1978) Soziologie der Moral. In: Luhmann, N./Pfürtner, S. H. (eds) Theorietechnik und Moral. Frankfurt/M., pp. 8–116.

Luhmann, N. (1980) Gesellschaftsstruktur und Semantik. Studien zur Wissenssoziologe der modernen Gesellschaft. Frankfurt/M.

Luhmann, N. (1984) Soziale Systeme. Grundriß einer allgemeinen Theorie. Frankfurt/M.

Lumsden, C. J. (1988) Psychological Development: Epigenetic Rules and Gene-Culture Coevolution. In: , K. B. (ed) Sociobiological Perspectives on Human Development. New York, pp. 234–267.

Lumsden, C. J./Wilson, E. O. (1983) Das Feuer des Prometheus. Wie das menschliche Denken entstand. Munich, Zurich.

Malinowski, B. (1922/79) Argonauts of the Western Pacific. London. (German: Argonauten des westlichen Pazifik. Frankfurt/M. 1979).

Maturana, H. R. (1982) Erkennen. Die Organisation und Verkörperung von Wirklichkeit. Ausgewählte Arbeiten zur biologischen Epistemologie. Braunschweig.

Meyer, P. (1982) Soziobiologie und Soziologie. Eine Einführung in die biologischen Voraussetzungen sozialen Handelns. Darmstadt, Neuwied.

Meyer, P. (1997) On the Origins of Human Social Institutions: A Three-Level Model. In: Thornhill, N. W. /Maryanski, A. M./Tooby, J./Cosmides, L./Meyer, P./Turner, J. H. Evolutionary Theory and Human Social Institutions: Psychological Foundations (= Ch. 6 in Weingart et al. (eds) Human by Nature. Between Biology and the Social Sciences). Mahwah NJ, London, pp. 245–252.

Morgan, C. L. (1923) Emergent Evolution. London.

Morgan, L. H. (1877/91) Ancient Society. New York. (German: Die Urgesellschaft. Untersuchungen über den Fortschritt der Menschheit aus der Wildheit durch die Barbarei zur Zivilisation. Stuttgart 1891).

Müller, K. E. (1984) Die bessere und die schlechtere Hälfte. Zur Ethnologie des Geschlechterkonflikts. Frankfurt/M.

Murdock, G. P. (1949) Social Structure. New York.

Murdock, G. P. (1957) World Ethnographic Sample. American Anthropologist 59: 644–687.

Ortner, S. B. (1972) Is Female to Male as Nature is to Culture? Feminist Studies 1: 5–31.

Ortner, S. B./Whitehead, H. (eds) (1981) Sexual Meanings. The Cultural Construction of Gender and Sexuality. New York.

Packer, C. (1977) Reciprocal Altruism in Papio Anubis. Nature 265: 441–443.

Parsons, T. (1937) The Structure of Social Action. New York.

Parsons, T. (1954/64) The Incest Taboo in Relation to Social Structure and the Socialization of the Child. British Journal of Sociology 5: 101–117. (German: Das Inzesttabu in seiner Beziehung zur Sozialstruktur und zur Sozialisierung des Kindes. In: Rüschemeyer, D. (ed) Tallcot Parsons Beiträge zur soziologischen Theorie. Darmstadt, Neuwied 1964, pp. 109–135.)

Paul, A. (1998) Von Affen und Menschen. Verhaltensbiologie der Primaten. Darmstadt.

Poole, F. J. P. (1982) The Ritual Forging of Identity: Aspects of Person and Self in Bimin-Kuskusmin Male Initiation. In: Herdt, G. H. (ed) Rituals of Manhood. Male Initiation in Papua New Guinea. Berkeley, Los Angeles, London, pp. 99–154.

Popper, K. R. (1995) Lesebuch: Ausgewählte Texte zur Erkenntnistheorie, Philosophie der Naturwissenschaften, Metaphysik, Sozialphilosophie, ed. by D. Miller. Tübingen.

Read, C. (1918) No Paternity. Journal of the Royal Anthropological Institute for Great Britain and Ireland 48.

Riedl, R. (1976) Die Strategie der Genesis. Naturgeschichte der realen Welt. Munich.

Riedl, R. (1982) Evolution und Erkenntnis. Antworten auf Fragen aus unserer Zeit. Munich, Zurich.

Riedl, R. (1985) Die Spaltung des Weltbilds. Biologische Grundlagen des Erklärens und Verstehens. Berlin, Hamburg.

Riedl, R. (1987) Kultur—Spätzündung der Evolution? Antworten auf Fragen an die Evolutions- und Erkenntnistheorie. Munich, Zurich.

Simmel, G. (1908) Soziologie. Untersuchungen über die Formen der Vergesellschaftung. Berlin.

Sommer, V. (1996) Heilige Egoisten. Die Soziobiologie indischer Tempelaffen. Munich.

Thornhill, N. W./Maryanski, A. M./Tooby, J./Cosmides, L./Meyer, P./Turner, J. H. (1997) Evolutional Theory and Human Social Institutions: Psychological Foundations. In: Weingart, P. et al. (eds) Human by Nature: Between Biology and the Social Sciences. Mahwah, N.J. & London, pp. 201–252.

Thurnwald, R. (1932) Werden, Wandel und Gestaltung von Familie, Verwandtschaft und Bünden im Lichte der Völkerforschung (= Die menschliche Gesellschaft, vol. 2). Ber-

lin, Leipzig.

Trivers, R. L. (1978) Parental Investment and Sexual Selection. In: Clutton-Brock, T. H./Harvey, P. H. (eds) Readings in Sociobiology. San Francisco, pp. 52–97.

Troost, K. M./Filsinger, E. (1993) Emerging Biosocial Perspectives on the Family. In: Boss, P. G. (ed) Theories and Methods. New York, London, pp. 677–710.

Tyrell, H. (1978) Die Familie als "Urinstitution": Neuerliche spekulative Überlegungen zu einer offenen Frage. Kölner Zeitschrift für Soziologie und Sozialpsychologie 30: 611–651.

Tyrell, H. (1988) Ehe und Familie—Institutionalisierung und Deinstitutionalisierung. In: Lüscher, K. /Schultheis, F./ Wehrspann, M. (eds) Die "postmoderne" Familie. Familiale Strategien und Familienpolitik in einer Übergangszeit. Konstanz, pp. 145–156.

Vester, H.-G. (1986) Transformation von Sinn. Ansätze zu einem Mehrebenenmodell. Zeitschrift für Soziologie 15: 95–106.

de Waal, F. (1997) Der gute Affe. Der Ursprung von Recht und Unrecht bei Menschen und anderen Tieren (Engl. original 1996). Munich, Vienna.

Weber, M. (1921/64) Wirtschaft und Gesellschaft. 2 half volumes. (first prints 1921). Cologne, Berlin.

Weingart, P./Mitchell, S. D./Richerson, P. J./Maasen, S. (eds) (1997) Human by Nature. Between Biology and the Social Sciences. Mahwah NJ, London.

Achim Stephan

Varieties of Emergentism

Abstract

In different disciplines such as philosophy of mind, cognitive science, and theories of self-organization the term 'emergence' has different jobs to perform. Therefore, various concepts of emergence are developed and examined. While weaker versions are compatible with property reductionism, stronger versions are not. Within philosophy of mind, particularly within the qualia debate there is a need for a strong notion of emergence, while in discussions of emergent properties of connectionist nets one can do with weaker notions of emergence.

Key words

Emergence, reduction, connectionism, qualia.

1. Introduction

In addition to having various technical uses, the term 'emergence' also has a use in ordinary language. Thus, sometimes people use the expression 'the emergence of x' just to mean that x has appeared or that x has come up. The term 'emergence' is used in this way in book titles such as "The Emergence of Symbols" (BATES 1979) and "The Emergence of Probability" (HACKING 1975). I will not focus on this ordinary use of 'emergence' in what follows. Instead, I will focus on the technical uses of 'emergence'.

In most technical uses, 'emergent' denotes a second order property of certain first order properties (or structures), namely, the first order properties that are emergent. However, it is controversial what the criteria are by which emergent properties are to be distinguished from non-emergent properties. Some criteria are very strong, so that few, if any, properties count as emergent. Other criteria are inflationary in that they count many, if not all, system properties as emergent. One of the consequences of this controversy is a great confusion about what is really meant by an 'emergent property', when this term is used in such different disciplines as theories of self-organization, philosophy of mind, dynamical systems theory, or connectionism.

Therefore, the second section of this article is intended to discuss, in a systematic way, several theories and concepts of emergence of different strengths. It will be shown that the weaker versions are compatible with property reductionism. In contrast, stronger versions are incompatible with property reductionism. Also, the important distinction between synchronic and diachronic theories of emergence is developed within this section.

In the third section, I examine the different concepts of emergence, distinguished in section 2, as they apply to particular properties. It will become evident that the concepts perform very different jobs, and so, one needs to be clear about which concept of emergence one wants to employ. For example, within philosophy of mind, particularly within the qualia debate there is a need for a strong notion of emergence, while in discussions of emergent properties of connectionist nets one can be content with weaker notions of emergence.

2. Weak emergentism, synchronic emergentism, and diachronic emergentism

There are three theories among the different varieties of emergentism deserving particular interest: *synchronic* emergentism, *diachronic* emergentism, and a *weak* version of emergentism. For synchronic emergentism the timeless relationship between a system's property and its microstructure, i.e. the arrangement and the properties of the system's parts, is in the center of interest. For such a theory, a property of a system is taken to be emergent, if it is *irreducible*, i.e., if it is not reducible to the arrangement and the properties of the system's parts. In contrast, diachronic emergentism is mainly interested in *predictability* of novel properties. For such a theory, those properties are emergent that could not have been predicted in principle before their first instantiation. By the way, these two stronger versions of emergentism are not independent of each other, since irreducible properties are eo ipso unpredictable in principle before their first appearance. Hence, synchronically emer-

gent properties are diachronically emergent, too, but not vice versa.

Both stronger versions of emergentism are based on a common 'weak' theory, which at the present pervades emergentist theorizing mainly in connectionism and theories of self-organization. Its three basic features—the thesis of *physical monism*, the thesis of *systemic* (or *collective*) *properties*, and the thesis of *synchronic determinism*—are compatible with reductionist approaches without any problems. The stronger versions of emergentism can be developed from *weak emergentism* by adding further theses.

Weak emergentism

The first feature of contemporary theories of emergence—the thesis of *physical monism*—is a thesis about the nature of systems that have emergent properties (or structures). The thesis says that the bearers of emergent properties (or structures) consist of material parts only. According to the thesis, all possible candidates for emergent properties, such as, e.g., being alive or being in a mental state, are instantiated only by material systems with a sufficiently complex physical microstructure. It excludes all *vitalistic* positions which hold that properties like being alive can be instantiated only by a compound consisting of an organism and some *supernatural* entity, e.g. an *entelechy* or an *élan vital*.[1] Thus, all substance–dualistic positions are rejected; for they base having cognitive states on supernatural bearers such as a *res cogitans*.[2] Hence, the thesis of physical monism denies that there are any supernatural components responsible for a system's having emergent properties. Particularly, this means that living or cognitive systems—whether artificial or natural—consist of the same parts as lifeless objects of nature. There is no reason to suppose that there are some *specific components* that belong just to those systems which are alive or able to cognize, but are missing in systems which are lifeless or unable to cognize. Instead, it is nothing but *specific constellations* of physico–chemical processes that show vital behavior or have mental qualitites.

(i) *Physical monism*. Entities existing or coming into being in the universe consist solely of material parts. Likewise, properties, dispositions, behaviors, or structures classified as emergent are instantiated by systems consisting exclusively of physical parts.

Embracing a *naturalistic* position, emergentists subscribe to a scientific position, but in so doing, they do not subscribe to reductionism.

While the first thesis puts the discussion of emergent properties and structures within the framework of a physicalistic naturalism, the second thesis delimits the type of properties that are possible candidates for emergents. It is the thesis of systemic properties.

This thesis is based on the assumption that *general* properties of complex systems fall into two different classes:[3] (i) properties which some of the system's parts also have, and (ii) properties that none of the system's parts have. Examples of the first class are properties such as being extended and having a velocity; sometimes such properties are called hereditary properties (however, 'hereditary' is not used in a biological sense). Examples of properties in the second class are walking, reproducing, breathing and having a sensation of pain. These properties are called systemic or collective properties.

(ii) *Systemic properties*. Emergent properties are systemic properties. A property is a systemic property if and only if a system possesses it, but no part of the system possesses it.

Sometimes systemic properties are characterized as 'novel' properties, only by virtue of being systemic. However, this does not attribute any temporal dimension; instead it characterizes a 'timeless' *systematic* relationship: in comparison to the properties of the system's parts, the system's properties are 'new'. Thus, one could, if one liked, distinguish between *diachronic* and *synchronic* novelties. However, I prefer to characterize *systematically* novel properties as does the thesis of *systemic properties*, only *diachronic* novelties in time should be characterized by a thesis of *novelty* (see below).

It should be uncontroversial that both artificial and natural systems with systemic properties exist. Those, who would deny their existence would have to claim that *all* of a system's properties are 'hereditary' properties, that is to say, that they are instantiated already by some of the system's parts. Countless examples refute such a claim.

While the first thesis restricts the type of parts out of which systems having emergent properties may be built, and while the second thesis characterizes in more detail the type of properties that might be emergent, the third thesis specifies the type of relationship that holds between a system's micro-structure and its emergent properties as a relationship of *synchronic determination*:

(iii) *Synchronic determination*. A system's properties and dispositions to behave depend nomologically on its micro-structure, that is to say, on its parts' properties and their arrangement. There

> can be no difference in the systemic properties without there being some differences in the properties of the system's parts or their arrangement.[4]

Anyone who denies the thesis of the system's properties synchronic determination either has to admit properties that are not bound to the properties and arrangement of its bearer's parts, or she has to suppose that some other factors, in this case non-natural factors, are responsible for the different dispositions of systems that are identical in their microstructure. She would have to admit, for example, that there may exist objects that have the same parts in the same arrangement as diamonds, but which lack the diamond's hardness, that may have hardness 2 instead of hardness 10 on the MOHS-scale. This seems to be implausible. Equally beyond thought is that there may exist two micro-identical organisms, one is viable and the other not. In the case of mental phenomena, opinions may be more controversial; but one thing seems to be clear: anyone who believes, e.g., that two creatures identical in micro-structure could be such that one is color-blind while the other can distinguish colors in the ordinary way, does not hold a naturalistic–physicalistic position.[5]

Weak emergentism as sketched so far comprises the minimal conditions for emergent properties. It is the common base for all stronger theories of emergence. Moreover—and this is a reason for distinguishing it as a theory in its own right—it is held not only by some philosophers (e.g., BUNGE and VOLLMER), but also by cognitive scientists (e.g., HOPFIELD, ROSCH, VARELA, and RUMELHART) in exactly its weak form. The three features of weak emergentism—(i) the thesis of *physical monism*, (ii) the thesis of *systemic properties*, and (iii) the thesis of *synchronic determination*—, however, are compatible with contemporary reductionist approaches without further ado. Some champions of *weak* emergentism credit the compatibility of 'emergence' and 'reducibility' as one of its merits compared to stronger versions of emergentism.

Synchronic emergentism

We come to the essential features of more ambitious theories of emergence, the theses of *irreducibility* (or *non-deducibility*) and of *unpredictability* of certain systemic properties. These theses are closely connected: Irreducible systemic properties are eo ipso unpredictable, in principle, before their first appearance. But besides irreducible properties, there also seem to be properties that can't be predicted before their first appearance on other grounds. Therefore, the thesis of unpredictability is more complex than the thesis of irreducibility of systemic properties. Thus, it is reasonable to start with a discussion of the thesis of irreducibility, which is easier to analyze.

BROAD's attempt to explicate a (strong) theory of emergence may count as downright classical; it reads:

"Put in abstract terms the emergent theory asserts that there are certain wholes, composed (say) of constituents *A*, *B*, and *C* in a relation *R* to each other; that all wholes composed of constituents of the same kind as *A*, *B*, and *C* in relations of the same kind as *R* have certain characteristic properties; that *A*, *B*, and *C* are capable of occuring in other kinds of complex where the relation is not the same kind as *R*; and that the characteristic properties of the whole *R(A, B, C)* cannot, even in theory, be *deduced* from the most complete knowledge of the properties of *A*, *B*, and *C* in isolation or in other wholes which are not of the form *R(A, B, C)* " (1925, p61).

According to BROAD's definition a systemic property, which is supposed to be nomologically dependent on its system's micro-structure (by the thesis of synchronic determination), is called *irreducible* and therefore *emergent*, if and only if it cannot be deduced from the arrangement of its system's parts and the properties they have 'isolated' or in other (more simple) systems.[6]

Although, prima facie, it looks as if BROAD's proposal gives us a clear and distinct explication of what it is for a systemic property to be irreducible (or non-deducible), a further look reveals that two different kinds of irreducibility having quite different consequences are concealed. As we will see, one type of irreducibility seems to imply 'downward causation', while the other seems to imply epiphenomenalism. The failure to keep apart the two kinds of irreducibility has muddled the recent debate about the emergence of properties.

To make things clearer, I shall first discuss when a systemic property is *reducible*. For this to be the case, two conditions must be fulfilled: The first is that from the behavior of the system's parts alone it must follow that the system has some property *P*. The second condition demands that the behavior the system's parts show when they are part of the system follows from the behavior they show in isolation or in simpler systems than the system in question. If both conditions are fulfilled, the behavior of the system's parts in other contexts reveals what systemic properties the actual system has. That is to say, those properties are reducible. Since

both conditions are independent from each other, two totally different possibilities for the occurrence of *irreducible* systemic properties will result: (a) a systemic property *P* of a system *S* is *irreducible*, if it does *not* follow, even in principle, from the behavior of the system's parts that *S* has property *P*; and (b) a systemic property *P* of a system *S* is *irreducible*, if it does *not* follow, even in principle, from the behavior of the system's parts in simpler constellations than *S* how they will behave in *S*.

Thus, a necessary requirement for a systemic property to be reducible is that its being 'instantiated' has to follow from the behavior of its bearer's parts. In other words: From the behavior of the system's parts it should follow that the system has all characteristic features that are essential for having the systemic property. BROAD, for example, takes this condition, which is enclosed in the first criterion for reducibility, to be always fulfilled in the case of the characteristic properties of chemical compounds and viable organisms. Their properties might be irreducible only by violation of the second criterion, what means that from the behavior of the system's parts in other (simpler) systems it would not follow how they will behave in the actual system. In contrast, he claims that the irreducibility of secondary qualities and phenomenal qualities results already from a violation of the first condition, since they were neither adequately characterizable by the macroscopic nor by microscopic behavior of the system's parts, even in principle. For, when we say that a certain object is red or a chemical substance has the smell of liquid ammonia, we do not mean that the corresponding system's parts *behave* or *move* in a certain way. No progress in the sciences could change this state of affairs in any way.[7] BROAD has illustrated the fundamental distinction between (behaviorally) *analyzable* and *unanalyzable* properties by pointing to characteristic properties of organisms and secondary qualities, respectively.

If secondary and phenomenal qualities are not analyzable,[8] even in principle, then there is no prospect that an increase of scientific knowledge will close the gap between physical processes and secondary qualities or between physiological processes and phenomenal states of consciousness (qualia), respectively.

We can now specify more exactly the feature of irreducibility which is central for *synchronic* emergence. Its first variant is based on the behavioral unanalyzability of systemic properties. It reads:

(a°) *Unanalyzability*. Systemic properties which are not behaviorally analyzable—be it micro- or macro-scopically—are (necessarily) irreducible.

However, even if secondary and phenomenal qualities belong to the class of unanalyzable properties, it does not follow that the specific behavior of the system's parts upon which those qualities supervene is itself not deducible from the behavior those parts show isolated or in other (simpler) systems. The irreducibility which results from a violation of the first criterion of reducibility does not imply, by itself, a violation of the second criterion of reducibility.

On the other side, however, even analyzable systemic properties can be irreducible and therefore emergent. This is the case when the second criterion of reducibility will be violated, i.e., when the behavior of the system's parts does not follow from their behavior in other (simpler) constellations. BROAD thinks that such examples of irreducible behavior might occur in chemical compounds and also in organisms.[9] His central idea is that the parts of a genuinely novel structure, such as, e.g., an organism in comparison to any inorganic compound, might behave in a way that is not deducible from the part's behavior in other structures. Implicitly, that means that the actual behavior of parts that interact in wholes does not result from their behavior in pairs.[10] If the behavior of some system's parts is irreducible in this respect, then all properties that depend nomologically on the behavior of the system's parts (for example, reproduction) are irreducible too.

Thus, we can specify more precisely the second variant of a systemic property's irreducibility. It is based on the non-deducibility of the behavior of the system's parts:

(b°) *Irreducibility of the components' behavior*. The specific behavior of a system's components within the system is irreducible if it does not follow from the components' behavior in isolation or in other (simpler) constellations.

A violation of the second criterion of reducibility, which is manifested in the irreducibility of the component's behavior, does not imply, however, a violation of the first criterion of reducibility. Systemic properties that cannot be reduced because the behavior of the system's parts is irreducible might nevertheless be behaviorally analyzable. Hence, the two criteria of reducibility as well as those irreducibilities that are based on the violation of these criteria are independent of each other. Summarizing, we get from (a°) and (b°) the following modified version of systemic property irreducibility:

(iv) *Irreducibility*. A systemic property is irreducible if (a) it is neither micro- nor macro-scopically

behaviorally analyzable, or if (b) the specific behavior of the system's components, over which the systemic property supervenes, does not follow from the component's behavior in isolation or in other (simpler) constellations.

Thus, we have to distinguish two totally different types of irreducibility of systemic properties. Equally different seem to be the consequences that result from them. If a systemic property is irreducible because the behavior of the system's parts, over which the property supervenes, is itself irreducible, this seems to imply that we have a case of 'downward causation'. For, if the components' behavior is not reducible to their arrangement and the behavior they show in other (simpler) systems or in isolation, then there seems to exist some 'downward' causal influence from the system itself or from its structure on the behavior of the system's parts. To be sure, if there would exist such instances of 'downward causation' this would not amount to a violation of some widely held assumptions, such as, for example, the principle of the causal closure of the physical domain. Within the physical domain, we would just have to accept additional types of causal influences besides the already known basal types of mutual interactions.

In contrast, the occurrence of unanalyzable properties does not imply any kind of downward causation. Systems that have unanalyzable properties that depend nomologically on their bearer's microstructures need not be constituted in a way that amounts to the irreducibility of their components' behavior. Nor is implied that the system's structure has a downward causal influence on the system's parts. All the more, there is no reason to assume that unanalyzable properties themselves exert a causal influence on the system's parts. Rather it is to ask, how unanalyzable properties might have any causal role to play at all. Since they are not behaviorally analyzable—that is to say, they neither seem to correspond to any 'mechanism' nor do they seem to result from any 'mechanism'—, it is hard to see how they could be causally effective themselves. If, however, one can not see *how* unanalyzable properties might play a causal role, then, it seems, such properties are epiphenomena.

Diachronic emergentism

All diachronic theories of emergence have at bottom a thesis about the occurrence of genuine *novelties*—properties or structures—in evolution. This thesis excludes at the same time all preformationist positions.

(v) *Novelty*. In the course of evolution exemplifications of 'genuine novelties' occur again and again. Already existing building blocks will develop new constellations; new structures will be formed that constitute new entities with new properties and behaviors.

However, bare addition of the thesis of novelty does not turn a weak theory of emergence into a strong one, since reductive physicalism remains compatible with such a variant of emergentism. Only the addition of the thesis of *unpredictability*, in principle, of novel properties will lead to stronger forms of *diachronic* emergentism.

A short consideration shows that systemic properties can be unpredictable in principle for two fundamentally different reasons: (i) they can be unpredictable because the micro-structure of the system, which exemplifies the property for the first time in evolution, is unpredictable. For, if the micro-structure of a newly emerging system is unpredictable, so are the properties which depend nomologically on it. (ii) However, a property can be unpredictable even though the novel system's micro-structure is predictable. That is the case if the property itself is irreducible: For, if systemic properties are irreducible, then they are unpredictable before their first appearance. However, this does not preclude that further occurrences of such properties might be predicted adequately.

Since in the second case criteria for being unpredictable are identical with those for being irreducible, this notion of unpredictability will offer no theoretical gains beyond those afforded by the notion of irreducibility.[11] Let us focus, therefore, on the first case: *unpredictability of structure*. This version of unpredictability passed almost unnoticed in 'classical' literature on emergentism during the 1920s, but because of strong interest in dynamical systems and chaotic processes this notion gains considerable significance.

The structure of a new formed system can be unpredictable for several reasons. Thus, belief in an indeterministic universe implies that there will be novel, unpredictable structures. However, from an emergentist perspective it would be of no interest, if a new structure's appearance would be unpredictable only because its coming into being is not determined, not to mention that most emergentists claim, anyway, that the development of new structures is governed by deterministic laws. But still deterministic formings of new structures can be *unpre-*

dictable in principle, if they are governed by laws which are attributed to deterministic chaos.

An essential outcome of the theory of chaos is that there exist—even very simple—mathematical functions, whose own 'behavior' cannot be predicted. Only the rise of 'experimental mathematics' on highly efficient computers has revealed, for example, the properties of various logistic functions. Their intra-mathematical unpredictability has to do with an aperiodic behavior of these functions, by which marginally different initial values of some variable can lead to radically distinct trajectories of the functions.

A standard example is the logistic function $f(x) = \mu x(1 - x)$ for $0 \leq x \leq 1$. For a parameter μ with $0 \leq \mu \leq 4$ the logistic function maps the interval [0, 1] onto itself. Of particular interest is, how parameter μ exercises an influence on the long term behavior of the function when iterated repeatedly. For $0 \leq \mu \leq 1$ the situation is obvious. All initial values of the variable x let the function $f(x)$ approximate the value 0 after sufficiently many iterations, thus, the origin is the attractor. For $1 < \mu < 3$ exists exactly one attractor A of value $A = 1 - 1/\mu$: the function balances out on a stable value. If μ equals 3, the fixed point of the function is 'marginally stable'; convergence is decidedly slowly—an indication for fundamental change in its behavior. For larger values dynamic becomes considerably complex. In the case of $3 < \mu < 1 + \sqrt{6}$ values oscillate between two fixed points. By increasing μ the attractors of period two will become instable, too. We get a cycle of period four (i.e., after four iterations the values of the function approach in each case the four fixed points). At 3.56 the period doubles again and becomes eight, at 3.567 it becomes sixteen, and then we get a quickly rising sequence of periods to 32, 64, 128, etc.—vividly one speaks of cascades. At about 3.58, this sequence comes to an end. The period has doubled itself infinitely many times. Hereafter, predictions do not seem to be possible. Marginally different initial values x lead to radically different trajectories of the iterated function. Values jump pell-mell, convergence and divergence are not discernible: chaos dominates.

Thus, it looks as if just the most exact science of all has led us back to one of the starting points of emergentism. Whereas—after pioneering successes in chemistry and physics—we today do not count properties and dispositions of chemical compounds any more among *synchronic* emergent phenomena, examinations of deterministic chaos suggest the existence of systems that might develop structures that are unpredictable in principle and thus might show *structure–emergent* behavior.

Of course, one could argue that a LAPLACEAN calculator could predict correctly even chaotic processes. Whether or not this could actually be the case, however, is not settled yet. It depends mainly on the question of what kind of information we allow such a creature of phantasy to have. For example, in ALEXANDER's considerations (cf. 1920, ii, pp72f, p328) LAPLACE's calculator knows several earlier states of the whole world and, in addition, all natural laws that govern changes in the world. He seems to be able to extrapolate from his knowledge of all events that have occurred in the universe so far even the course of chaotic processes. But on what basis could he do that? Since chaotic processes are aperiodic, one can not determine definitely from those processes that have occurred up to a certain time the exact formula which would describe their further course. Even if the further course of the world is governed by deterministic laws, it does not follow from the earlier events and states alone, by *which* laws it is governed. Entirely different continuations seem to be compatible with the earlier course of the world. Therefore, even a LAPLACEAN calculator could fail in his predictions. If one grants, however, that he knows *all* details of earlier world states—up to infinitely many digits—, and if one grants that he knows a priori which processes are governed by which *specific* chaotic laws, then, of course, he would be able to predict the forming of structures that are governed by these laws.[12] I will leave it open whether or not it is plausible to ascribe such a knowledge to such a fabulous creature. However, we can preclude that foretellers of our mental capacities have these abilities, and suppose that where chaos exists, structures exist that are unpredictable in principle, and that is to say, that there will be *structure emergence* in our sense.

(vi) *Structure–unpredictability*. The rise of novel structures is unpredictable in principle, if their formation is governed by laws of deterministic chaos. Likewise, any novel properties that are instantiated by those structures are unpredictable in principle.

Summing up, it may be said a *systemic property* is *unpredictable* in principle before its first appearance, if (i) it is irreducible, or if (ii) the structure which instantiates it, is unpredictable in principle before its first formation. Although unpredictability of structure always implies unpredictability of properties instantiated by the structure, it does not thereby imply the irreducibility of the properties instantiated by the structure. As far as that goes, unpredict-

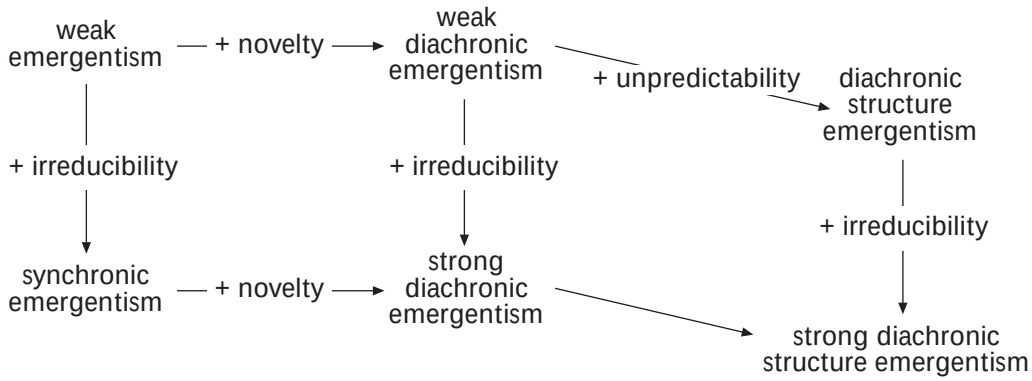

Figure 1: Logical relationships that hold between the different versions of emergentism.

ability in principle of systemic properties is entirely compatible with their being reducible to the microstructure of the system that instantiates them.

Synopsis

Figure 1 depicts the logical relationships that hold between the different versions of emergentism.

Weak diachronic emergentism results from *weak emergentism* by adding a temporal dimension in the form of the thesis of novelty. Both versions are compatible with reductive physicalism. Weak theories of emergence are used today mainly in cognitive sciences, particularly for characterization of systemic properties of connectionist nets, and in theories of self-organization. *Synchronic emergentism* results from weak emergentism by adding the thesis of irreducibility. This version of emergentism is important for the philosophy of mind, particularly for debating nonreductive physicalism and qualia. It is not compatible with reductive physicalism any more. *Strong diachronic emergentism* only differs from synchronic emergentism because of the temporal dimension in the thesis of novelty. In contrast, *structure emergentism* is entirely independent of synchronic emergentism. It results from weak emergentism by adding the thesis of structure–unpredictability. Although structure emergentism emphasizes the boundaries of prediction within physicalistic approaches, it is compatible with reductive physicalism, and so it is weaker than synchronic emergentism. Theories of deterministic chaos in dynamical systems can be acknowledged as a type of structure emergentism. Likewise, its perspective is important for evolutionary research. In comparison to the above mentioned versions of emergentism the synthetic position of *strong diachronic structure emergentism* has no equivalent in recent discussion. Most important from a theoretical point of view are *weak emergentism*, *synchronic emergentism*, and *diachronic structure emergentism*.

3. Emergence in the qualia debate and in connectionism

Let us turn to some specific cases to consider how the different concepts of emergence are applicable. We will see that in one of the central debates within philosophy of mind, namely the debate about the nature of qualia, there is need for a strong notion of emergence such as that of synchronic emergentism. In contrast, in connectionism a weaker notion of emergence is employed.

Emergence in the debate over whether qualia are physical

In recent debate about qualia, NAGEL, BLOCK, JACKSON, LEVINE, CHALMERS and MCGINN, among others, have argued in one way or another that qualitative mental phenomena are not reducible to physical or functional states, respectively. If their arguments succeed, they imply emergentist or substance–dualistic positions. Most interesting and powerful seems to be LEVINE's so-called 'explanatory gap'–argument, which I will consider closely in the following.

LEVINE starts with comparing two statements, namely (i) 'pain is the firing of C-fibers', and (ii) 'heat is the motion of molecules'.[13] The decisive difference between the two identity statements, according to LEVINE (1983), is that the second is *fully explanatory*, while the first is not. The second identity statement is assumed to be fully explanatory,

because knowledge of natural laws helps us understand why the motion of molecules has exactly the causal role usually ascribed to heat. Thereby, it is presupposed that the macro-physical concept of heat can be fully explicated by heat's causal role. In other words: statement (ii) is fully explanatory because some system's property of heat is reducible in respect to the motions of molecules, and so far it is not emergent. On the other hand, the reason for statement (i) not being fully explanatory is, LEVINE says, that the notion of pain is not exhausted by the causal role of pain. And, what is true for pain seems to be true for all other phenomenal states.

Let's see why pain and other qualia are so resistent to explanatory reduction. According to LEVINE, reduction that is explanatory requires two stages: "Stage 1 involves the (relatively? quasi?) *a priori* process of working the concept of the property to be reduced 'into shape' for reduction by identifying the causal role for which we are seeking the underlying mechanisms. Stage 2 involves the empirical work of discovering just what those underlying mechanisms are" (1993, p132).

If one claims that a reduction that is explanatory is impossible *in principle*, as is claimed for qualia, that does not imply a failure of the second task. What is implied is a failure, in principle, of the first task. Or, as LEVINE puts it: "to the extent that there is an element in our concept of qualitative character that is not captured by features of its causal role, to that extent it will escape the explanatory net of a physicalistic reduction" (1993, p134). Thus, LEVINE's *synchronic qualia–emergentism* is based on two theses:

(1) The reduction of a systemic property *P* is explanatory if and only if the realization base exhausts exactly the causal role which is constitutive of *P*.

(2) Phenomenal properties (or states) are not fully graspable by the features of their causal role.[14]

Several responses are possible to LEVINE's claim: (i) one tries to avoid emergentism by showing either how properties that are not fully graspable via their causal roles, might yet be reducible explanatorily, or by showing that phenomenal qualities are graspable adequately via causal roles. For both variants, however, there exist nothing more than first attempts or statements of intentions. (ii) One accepts both theses and, thereby, an emergentist position. But then, additional questions arise: To what type of psycho–physical theories does synchronic qualia–emergentism belong? Is it still a physicalistic position, or rather a kind of property dualism?

Anyway, if LEVINE's 'explanatory gap'–argument succeeds then qualia are extremely good candidates for emergent properties in the (strong) synchronic sense.

Emergence in connectionism

In the last decade, connectionism has received great attention in cognitive science. Its core idea is to assume a network of elementary units that have a certain level of activation. Units are connected with each other. Units whose activation exceeds a certain threshold, can activate or inhibit other units according to certain weights that specify prevailing connections.

To see to what extent emergentist considerations are relevant for connectionism, I shall first examine more closely the parameters that specify a connectionist net. Each net is determined essentially by three factors: (i) by the number of units and connecting links which hold between them; (ii) by the function that determines the level of activation for each unit; and (iii) by the rule that determines how connection weights will change.

In each case the number of units and the links between them are fixed; they make up, so to speak, the 'skeleton' of a network which is static under ordinary circumstances: neither the number of units nor the structure of their links will change. A system's actual dynamic results from the possibility of modifying the weights of its internal connecting links. From a macroscopic point of view, these continuous processes of accomodation can be seen as learning procedures. Thus, a connectionist net 'learns' by locally determined changes of its connections' weights, and not by adding some further propositions to its data base. When a net is fed with various inputs after its practice time, it will calculate its outputs or 'answers' with stable weights in general.

Behavior and properties of connectionist nets give rise to emergentist considerations in many ways. Three aspects should be discerned: first, connectionist nets obviously have systemic properties, that is they have properties their parts do not have. Thus, a net's properties are at least weakly emergent. However, it remains to be determined whether systemic properties of nets are emergent in a strong sense, namely synchronically emergent. Secondly, many systemic properties of nets seem to be emergent in a 'phenomenological' way. By this, I mean that the properties appear, or come into being by themselves if nets get adequate stimuli. These facts

of the case are referred to in English by the word 'emergent' in its ordinary use. No specific theory of emergence is implied by this usage. Since some connectionists make use of the word 'emergent' in its ordinary use intermingled with a more technical use, it is important to tell the notions apart. Eventually, connectionist nets develop during their training phase—in a somewhat mini-evolutionary process—their 'soft' structures, by which I understand the specific distribution of link weights. Thus, the question arises whether this formation of structure is an interesting case of structure emergence.

Let's examine first the relationship between global net properties and their realization base, namely the net's structure and its parts' properties. Considerations of connectionist net's architectures and their modes of operation reveal that only trained nets show typical macroscopic properties such as 'rule following', 'schemata formation', or 'pattern recognition'. Untrained nets do not have those (cognitive) properties, they have only the disposition to acquire them. Macroscopic properties of trained nets supervene upon both their given hard structure, and their acquired soft structure. They are fully reducible to the organization of the net in consideration, the properties of its units (namely their activation formula), and the properties of links consisting between its units (nameley distribution of weights, and formula for changing weights). If these quantities are known, the output–behavior of any net can be predicted exactly and explained. It is obvious that a net's parts, namely its units and the links between them, do not have any of those macroscopic (cognitive) properties. So far, these properties a net acquires by training are typical systemic properties. However, since they are not irreducible systemic properties, but are completely deducible from a net's structure, and its parts' and links' properties, a net's systemic properties are merely weakly emergent. They are not synchronically emergent.

RUMELHART and MCCLELLAND discuss in great detail net properties which they call 'emergent', and stress that connectionist approaches do not imply reductionistic, but interactionistic positions.

"We are simply trying to *understand* the essence of cognition as a property emerging from the *interactions* of connected units in networks. We certainly believe in emergent phenomena in the sense of phenomena which could never be understood or predicted by a study of the lower level elements in isolation. [...] This is the case in many fields. Knowing about the individuals tells us little about the structure of the organization, but we can't understand the structure of the higher level organizations without knowing a good deal about individuals and how they function. This is the sense of emergence we are comfortable with" (1986, p128).

However, RUMELHART and MCCLELLAND's claim that connectionism amounts to a non-reductive position results from an inappropriate strong notion of reduction. Both authors, one must know, take a system's properties as reduced only when either some of the system's parts have these properties already, or when the system's property can be reduced to some linear interactions of the parts. Yet, almost no systemic property would be reducible according to these criteria. At the same time, RUMELHART and MCCLELLAND concede that a net's behavior is completely intelligible, if one takes into account all interactions between its units, that is to say, if one considers a system's hard and soft structure. Hence, even from their point of view, connectionism is not an instance of synchronic emergentism.

In discussions of connectionist nets' behavior ordinary use and technical use of the notion of emergence often gets intermixed. For example, RUMELHART and MCCLELLAND reiterate that macroscopic properties emerge from micro-level interactions: "[M]any of the constructs of macrolevel descriptions such as schemata, prototypes, rules, productions, etc. can be viewed as *emerging* out of interactions of the microstructure of distributed models" (1986, p125; italics are mine). By this characterization, they lay stress upon the fact that a net's systemic properties come into being from the complex behavior of the net's components: rules and schemata can be available without being explicitly fed into the system. Here, emergence is not discussed in a technical sense, rather the term is used in its ordinary sense to describe a system's abilities to acquire systemic properties by self-organizational processes. The temporary manifestation of schemata that were already latently 'in' the link's weights is interpreted, then, as an emergent property of the net. Connectionists, thus, mainly point to 'emergent rules' or 'emergent schemata' to demarcate their position from 'classical' representationalism, accordingly to which all rules and schemata have to be fed in explicitely (see HORGAN/TIENSON 1996).

There is a further feature of connectionist nets that provokes emergentist considerations: during the phase of training or learning a net runs through a mini-evolutionary process—link weights are adapted such that the net is enabled to handle the tasks it is supposed to master. Within this time the

so-called 'soft structure' of the net develops.[15] Only when the links' weights are adjusted adequately does a net has available desired macro-properties, that is, only then can it develop schemata, recognize patterns, or make use of rules. Those are not implemented explicitely as they are in symbol manipulating devices, but are extracted from given material. However, this is not a case of genuine structure emergence: not only does the distribution of weights result from deterministic principles, the changes of weights are even calculable exactly, if we know the learning rule, the activation formula, the unit's initial activation, the intial weights, and the inputs.

Even though we therefore should not speak of structure emergence in connectionist networks, regarding their soft structure, nets show a tremendous plasticity, when compared with other objects, even when compared with other dynamical systems. Chemical compounds, to give an example, have no degrees of freedom to change their internal structure. In this respect connectionist nets differ clearly from seeming analogic cases such as diamonds, which were referred to by RUMELHART and MCCLELLAND to explain 'emergent' system's properties (1986, p128). Diamonds are not dynamical systems that realize only after a certain number of reiterated steps the property of being hard. The diamond's property of being hard is always manifest, it does not emerge.

To sum up, connectionist nets do not instantiate any stronger type of emergence. Neither are the net's properties synchronically emergent, nor is the formation of a net's soft structure a case of structure emergence. In the weak sense in which macroscopic properties of nets are emergent, all systemic properties of complex systems are emergent. A difference to many other systems exists at best in the plasticity of nets and in their capacity to develop in a training phase by themselves adequate 'attractors' to cope with given tasks. Corresponding macroscopic properties will become manifest only temporarily during treatments. This second order property might justifiably be characterized as 'phenomenological' emergence. Only some dynamical systems have this property.

4. Conclusion

In particular, I have distinguished three versions of emergentism: weak emergentism, (strong) synchronic emergentism, and diachronic structure emergentism. Synchronic emergentism results from weak emergentism by adding the thesis of irreducibility. It turned out that this version of emergentism is important for the philosophy of mind, particularly for debating qualia. However, this does not establish that qualia are emergent phenomena in the strong sense. But they are good candidates for being so. Connectionism, on the other hand, does not treat any phenomenon as synchronically emergent, nor does it treat novel structures as candidates for structure emergence. Phenomena discussed by connectionism are emergent only in the weak sense.[16]

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Notes

1 'Supernatural' properties are meant to be hyperphysical, i.e., as independent from (physical) nature and their laws.

2 In the history of emergentism, however, there were theories of emergence that did not claim the thesis of *physical monism*; instead, they took *mental* or *neutral* building blocks as fundamental (cf. BROAD 1925, pp610–653). Anyway, the thesis of physical monism is not questioned by main stream debate today.

3 General properties are properties of a general type, such as having a weight, or being liquid; they are not specific properties, such as having a weight of 154.5 pounds or being liquid by a temperature of 1200 °C.

4 In recent debate, the thesis of *synchronic determination* is sometimes stated in a less stronger version as the thesis of *mereological supervenience*, which claims that a systems's properties (or dispositions) supervene on its parts' properties and their arrangement. Then, too, there is no difference in the systemic properties without differences in the part's properties or their arrangement. The thesis of mereological supervenience, however, is weaker than the thesis of synchronic determination, since it does not claim the *dependence* of the system's properties from its micro-structure, it only claims their *covariance*.

5 However, similar considerations hold for propositional attitudes only, as long as one does not subscribe to externalism, that is to say, if one does not claim that, e.g., the content of a belief depends essentially on the nature of the referents of the believer's thoughts and concepts.

6 Properties that might be ascribed to a system's part 'in isolation' are, according to BROAD, properties that depend essentially on the micro-structure of the part, while external factors, such as the part's arrangement and its neighboring parts, can be seen as almost irrelevant for the part's having these properties (cf. 1919, pp112f).

7 However, whether reference to linguistic usage might answer questions concerning reducibility in a definite way is controversial. Particularly, CHURCHLAND has opposed arguments of the BROADIAN style (see 1988, pp29ff).

8 Properties that are called 'unanalyzable' for simplicity here, might be analyzable in other ways than by behavioral features. A certain smell, for example, might be analyzed as a mixture of the smells of musk and fish-meal. This, however, would not be an analysis based on concepts of motion and behavior.

9 BROAD has also examined 'in abstracto' under what conditions the behavior of system's components can be irreducible (cf. 1919, pp113f). Recently, BECHTEL has held a similar position: „although studying the properties of amino acids in isolation may reveal their primary bonding properties, it may not reveal to us those binding properties that give rise to secondary and tertiary structure when the amino acids are incorporated into protein molecules" (1988, p95).

10 Scenarios of this kind are discussed already by MILL and FECHNER (cf. STEPHAN 1999, sections 6.1. and 7.3.).

11 A difference in extension between both notions could result only in respect to those properties, which, although reducible, are not predictable before their first appearance. A reducible property is unpredictable before its first appearance if the behavior of the system's components upon which it supervenes does not follow from their behavior in those systems that exist at the time of prediction. The notion of unpredictability widened in this way would depend, however, in a very contingent way on the chronological order of systems coming into being in evolution. Therefore, such a notion should not be important in qualifying the notion of emergence.

12 LAPLACE himself assumed that his calculator knows all laws governing nature, but he took those laws to be laws of NEWTONIAN physics. During his time, nobody knew anything about aperiodic chaotic processes.

13 Talk about 'firing of C-fibers' has its firm place in literature about the qualia–problem. It is, however, only a fill-in for an adequate neurophysiological analysis of a pain's material base.

14 Notice the analogies between LEVINE's theses and the criteria for irreducibility in the section above.

15 The developing 'soft structure' depends on two factors, the net's hard structure, and the given inputs, that is external influences on it.

16 A longer version of this paper was published under the title "Varieties of Emergence in Artificial and Natural Systems" (1998). For more details—both historically and systematically—cf. my book on "Emergenz" (1999).

References

Alexander, S. (1920) Space, Time, and Deity. Two Volumes. London: Macmillan.

Bates, E. (1979) The Emergence of Symbols. New York: Academic Press.

Bechtel, W. (1988) Philosophy of Science. An Overview for Cognitive Science. Hillsdale, NJ: Lawrence Erlbaum Associates.

Broad, C. D. (1919) Mechanical Explanation and its Alternatives. Proceedings of the Aristotelian Society 19: 86–124.

Broad, C. D. (1925) The Mind and its Place in Nature. London: Kegan Paul, Trench, Trubner & Co.

Churchland, P. (1988) Matter and Consciousness. Revised Edition. Cambridge, MA, London: MIT Press.

Hacking, I. (1975) The Emergence of Probability. Cambridge: Cambridge University Press.

Horgan, T./Tienson, J. (1996) Connectionism and the Philosophy of Psychology. Cambridge, Ma., London: MIT Press.

Levine, J. (1983) Materialism and Qualia: The Explanatory Gap. Pacific Philosophical Quarterly 64: 354–361.

Levine, J. (1993) On Leaving Out What It's Like. In: Davies, M./Humphreys, G. W. (eds) Consciousness. Oxford, Cambridge, MA: Blackwell, pp. 121–136.

Rumelhart, D. E./McClelland, J. L.(1986) PDP Models and General Issues in Cognitive Science. In: Rumelhart, D. E./McClelland, J. L./the PDP Research Group, Parallel Distributed Processing. Explorations in the Microstructure of Cognition. Vol. 1. Cambridge, MA, London: MIT Press, pp. 110–146.

Stephan, A. (1998) Varieties of Emergence in Artificial and Natural Systems. Zeitschrift für Naturforschung 53c: 639–656.

Stephan, A. (1999) Emergenz. Von der Unvorhersagbarkeit zur Selbstorganisation. Dresden, München: Dresden University Press.

Walter Hauptmann

Law as a Result of Cultural Evolution

Abstract

Law can be understood as a product of cultural evolution, whose main differences to biological evolution can be found in the tradigenetic manner of information transfer and related increasing learning capacities. For both processes it is necessary to reduce complex phenomena to relevant informations, what can lead to errors as demonstrated by biological and legal dummies. Less reducing processes with more detailled analysis can lead to erratic increase of information, what can cause a collapse of the system whose optimization was intended.

Key words

Cultural evolution, biological evolution, evolution of law, tradigenetic transfer of information, biogenetic transfer of information, reduction of complexity.

I. Introduction

The basic principles of the *biological* evolution have been known for a long time. By means of sexual recombination and spontaneous mutations of the genotype of organisms the offspring of them produce changes of characteristic features the carriers of which are adapted to their respective environment to a higher or lower degree than their genetic predecessors. Nature learns more or less from trial and error. He who is better adapted to environment will sooner or later displace the one who is worse adapted in this respect. The latter will be according to the circumstances decimated or even exterminated and is doomed to extinction. That means that biological evolution is an endless process of adaptation and selection with essentially open outcome.

More or less the same course is taking the process of *cultural* evolution, that is to say wherever a population is developing some new pattern of behavior being passed on to the following generation not by means of hereditary transmission, i.e., in a biogenetic way, but through information by speech, writing, picture etc., accordingly in a *tradigenetic* manner (WUKETITS 1990, p34, pp74ff; HELSPER 1996, p248). Also qualities of the tradigenetic type may, of course, turn out in the following generation to be an advantage or disadvantage in the struggle for existence. Accordingly some newly acquired qualities also determine the chances of survival of this population in their respective environment. As far as man is concerned the difference between biogenetic and tradigenetic development consists mainly in the fact that only tradigenetic flow of information is able to transmit within a very short time a comparatively extreme lot of data. In other words adaptation through cultural learning takes disproportionately less time than adaptation by means of genetic learning.

In order to form an idea of the relevant dimensions the following assessment by Ernst FIALA, the former director of the project planning department of the Volkswagen Trust, should be taken into consideration: whereas in 1990 he estimated the genetic growth at an average percentage of two millionth per year (FIALA 1990, p58f) in a more recent publication of 1994 he lowered this figure down to a percentage of just one millionth per annum (FIALA 1994, p3). Anyway it can be stated that the rate of genetic growth is enormously low in comparison with the increase of our knowledge obtained in a tradigenetic way. As Prof. FIALA furthermore points out our store of knowledge is actually growing at the rate of 10 percent per year. Since 1850, that is to say within a period of little less than 150 years, this store would have increased at the factor of 300,000. This rough comparison may illustrate the velocity of the two ways of learning.

Apart from this difference in the velocity of learning there are, however, numerous analogies between the two mentioned types of evolution. Therefore one may at least attempt to interpret legal orders likewise as a result of a cultural process of evolution. Such an experiment of ideas does not only reveal similarities between both types of evolution but is also suitable for providing us a better understanding of specific system characteristics of law.

II. Selection–approved algorithms in nature—operational definitions in law

Both systems are confronted with the problem of continuously coping with huge amounts of data from their respective environments as simply, quickly and reliably as possible. Both in nature and in law this may be accomplished only at the expense of a quite considerable reduction of complexity: A tick, e.g., how does it recognize among its many sense stimuli when there is a suitable prey, i.e., a warm-blooded animal, beneath it? If this quite simple species were dependent on protracted cognitive reflections on the zoological character of warm-blooded animals, it would never have had a chance of survival: The species "tick" has, what is more, learned in the course of evolution to reduce considerably the complex notion "warm-blooded animal": it "defines" as is generally known everything being beneath it and exhibiting specific combinations of characteristic features as potential prey: temperature of 37 degrees Celsius (blood temperature) and at the same time smell of butyric acid. This primitive "search program" is just as simple as ingenious. Errors may certainly not be totally excluded. Yet under practical conditions this system operates almost perfectly. This strategy of processing has to do with one out of many "selection–approved algorithms" following the terminology of Rupert RIEDL.

At first sight it may appear just strange to mention strategies of survival of primitive small animals in the same breath as such a sublime institution like human law. Nevertheless both in nature and in legal practice quite analogous problems of capacity and processing do occur. Even in the (most to least far-reaching) surrounding field of man, from outer space to family, billions upon billions of conflicts are imaginable that have to be solved by written and also unwritten law. Contrary to the number of possible conflicts of interests between human beings even the capacity of data gathering and processing of the so-called homo sapiens is more or less absolutely finite. Consequently, the flagrant disproportion between obligation (= to shall) and ability (= to know) can be overcome or at least eased also in this context only by means of a quite considerable reduction of complexity.

1. Sufficient specification of the will

In the course of cultural evolution of nearly 4000 years since the first appearance of written legal sources such as the Codex Hammurapi the following strategies of survival and adaptation have, among others, proved successful as far as law is concerned: Postulates of a too common, although very reasonable nature turned out to be unrealizable or at least scarcely realizable. In this context one may think of a norm saying, e.g., "Harmful social behavior shall be adequately suppressed". The more or less reliable realization of such common postulates and notions in social reality requires a certain specification of the will. Abstract goals can be realized only through instructions for taking concrete actions. And this applies not only to secular orders but as well to the religious sphere. Accordingly also Thomas von AQUIN, e.g., has attributed the "lex naturalis" *do the right—don't do the wrong* which had already been formulated by ARISTOTLE to a "lex aeterna", postulating, however, at the same time its concretization by means of "leges humanae" (HAFT 1990, pp123ff).

Secular legal orders, among many other things, e.g., strive for the abstract goal "road traffic safety". This is being concretized, for instance, by the prohibition of driving motor vehicles without licence or exceeding certain maximum speeds or consuming too much alcohol when driving. And the latter has to be explained by further definition such as the fixation of a maximal blood–alcohol level up to 0.8 per mill.

Of course these operational definitions have their weak points and limits also within the framework of law: drivers who are able to carry a lot may, empirically speaking, drive "more safely" with a pro mille content of 0.9 than persons of a contrary disposition in this respect with only 0.6. Nevertheless the former will be punished whereas the latter will remain without sanctions, at least as far as the penal norm relating to the blood–alcohol level is concerned. Also in this field it must be sufficient—as already demonstrated by the example of the search program of the tick—if the applied operational definition is able to hit the "envisaged" cases at least to a large extent, even if it may fail in a particular case. Consequently, the statuary definition of an offence is not useless as such already if it may produce mistakes anyway, but only in case it leads to absurd results on a socially intolerable scale. In other words a certain percentage of "waste" cannot be avoided and has to be accepted. This shall be demonstrated by a few examples:

A case of regulation occurring in everyday life in thousands could be, e.g., the midsummer traffic stoppage in the city of Salzburg. If during the long vacation in summertime there is a longer period of

rainy weather in the nearby lake district according to experience tens of thousands of holiday–makers all at once make-up their minds to visit the city of Salzburg by car. In the inevitably resultant traffic jam also service vehicles of police, ambulance or fire-brigade get stuck.

How can this problem be eased with adequate means, in a short time, with the lowest personnel expenditure etc. in a satisfactory manner? Also here this will be possible only by means of a quite considerable reduction of complexity to two essential signals within a very complicated system:

- If in the case of raining a certain "indicator-garage" in the city of Salzburg is occupied to an extent of two thirds traffic alert will be announced. The competent road control authority will then be proceeding in certain access roads according to a very simple program:
- All cars with an "S" (= Salzburg-Stadt) or "SL" (= Salzburg-Land) on their number plates will be allowed to go right into town. All the other cars will be refused. It is intended to exclude through this selective measure the holiday–makers and let pass only the local car drivers. For the latter are supposed to go downtown at least predominately for other purposes than mere sight-seeing.

The "search program" taken by the road control authority as a basis is more or less as simple as that one of the ticks and also shows similarly reliable results. The purpose of this regulation (ratio legis) will be achieved for the most part, the otherwise impending collapse of traffic won't take place, police, ambulance or fire-brigade will still be able to be in action etc. On the other hand, however, this program has two essential weak points: mere sightseers, e.g., may nevertheless pass if they are using only a car with an S or SL on their respective number plates. This applies, of course, not only to local people from the city and the surroundings of Salzburg but also, for instance, to foreigners passing their holiday in the mentioned lake district and borrowing the car from their host in order to be able to go downtown as desired.

The prohibition of access is therefore not fully efficient in such cases. If in the reverse case, e.g., somebody in a car with a Munich number plate wanted to take his sick child to town for urgent treatment he would be unlucky. He would be falsely defined by this search program as a mere holiday–maker and consequently refused by the police. In this case the prohibition hits a road user who was certainly not intended to be excluded from access.

Taken all in all one may achieve with this algorithm—and numerous comparable ones—the desired social purpose but may not exclude unjust and frequently even absurd results in atypical individual cases.

Practically the same applies, for instance, also to the protected age up to 14 years regarding sex offences in criminal law. The legislator then defines the abstract notion of "psycho–sexual maturity". On the whole this limit adequately differentiates "adults" from "children" and protects the latter from sexual contacts with the former. Among the concrete individual cases there will, however, also occur immature persons of the age of 15 who, strictly speaking, unjustifiably are not protected. And on the other hand likewise premature 13 or 14-year-old juveniles are imaginable for whom such a protection may appear not essential.

Of course innumerable further examples could be presented here revealing over and over again the same just universal weakness of the legal system. Even the most useful norm does not in every case lead to a suitable result. For borderline cases each norm is partly too narrow (loss of operationalization), partly too wide (surplus of operationalization) (HAUPTMANN 1993, pp40ff).

2. Consequences of hyper-regulations

This cardinal weakness of the system provokes the question if it is not possible in principle to form better and maybe even ideal legal definitions. This would mean concretizations of the will by precise concept formation through complete enumeration of all relevant elements. Yet all previous attempts in this direction were doomed to failure. From a certain degree of concretization of a norm upwards—which for its part undoubtedly cannot be determined easily—there will be a growing disproportion between the increase in clarity attained through additional definition efforts and the swelling volume of the text. In other words the "cost" will be rising progressively, the "profit" however digressively.

A concrete example taken from the Road Traffic Regulations demonstrates that it might be unsatisfactory for car drivers to read in the Road Traffic Act merely that they should keep an "adequate distance" with respect to cars driving in front of them, for this standard depends as is well known on many factors such as velocity of the vehicles involved, condition of brakes and tires, gradient and other conditions of the road surface, reaction ability of the driver, traffic density, winding road etc.

At first sight it might appear desirable to embody all these subfactors in the law itself. Such a law, however, would be not at all more understandable or easier to handle in spite of a very strong swelling of its text. One would just cut off the head of the hydra of an unclear notion with the consequence that ten other ones would be regrowing and with them plenty of new unclearness would be emerging after so much trouble of the legislator. This may also be the reason why the Austrian Common Civil Code (= Allgemeines Bürgerliches Gesetzbuch, ABGB) with its 1502 articles still has been living on since 1811—although to some extent with modifications—whereas the almost thirteen times more voluminous Prussian Common Code (= Allgemeines Landrecht, ALR) of 1794 was in force only until 1900. The latter went too much into details and corresponding to its 19,199 regulations—though not only comprising civil law—its handling was rather difficult (HAFT 1990, p96f; RÜPING 1991, p71).

A specification of the legal order would not only mean a merely punctual inflation. Accordingly, the problem is not only a single formulation in a specific article but, what is more, *everything* would have to be regulated more exactly, more precisely and more in detail. And this would entail a huge increase in legal norms that neither legal experts nor even less non-jurists could cope with.

a) The example of the deciduous tree. The above mentioned problem can be illustrated with the picture of a deciduous tree: Through the refinement of the system from the stem upwards the quantity of information rises progressively. A branch would correspond, for instance, to a single *article* of a certain law. This article may form a short definition of legal elements which alone are perhaps not yet clear enough. An attempt of further clarification of this text could take place, e.g., in three *paragraphs* 1, 2 and 3. Should the latter still appear not yet unequivocal they would need further explanation by means of the *letters* a, b and c and these letters might in the end be clarified through the *figures* 1, 2 and 3 respectively. Of course this example represents an ideal type. Not all norms have such a fine differentiation. But in principle this would be imaginable. From step to step of this process of concretization the quantity of information that has to be coped with rises. Instead of one single unclear "stem article" in this example further 3 paragraphs, 9 letters and even 27 figures, i.e., altogether just 40 information units would have to be processed. At this "cost" however only one single element (e.g., one article) within a legal system would have been put more precisely and refined.

b) The example of the sea-urchin. Every law is composed of a variety of articles and every national legal order of a variety of laws (and other general norms). The above outlined increase in quantity of information per single element consequently would have to be "projected" onto the respective levels (law, national legal order as a whole, etc.). To illustrate such a process the picture of a sea-urchin may be taken into account. Its round body is all over bristling with quills. The whole ball-shaped figure would, for instance, correspond to the above mentioned Austrian Common Civil Code and each single quill to an article of this law. As already demonstrated by the example of the deciduous tree, however, also the individual articles ramify—unlike real sea-urchins—into many subunits (paragraphs, letters, figures...). Of course this picture may represent just as well a complete national legal order. The single quills ramifying outwards would be in this case the respective single laws of this legal order. And this spinous figure could likewise be interpreted as the globe: Each of its quills ramifying outwards would then represent a single national legal order.

c) The example of the spherical shells. The basic relationship remains always the same: right on the globe there is a still limited number of comparatively thick "stems". The latter ramify into unproportionally numerous "branches" and still far more "twigs" which for their part possess an indeterminable number of "leaves".

The respective levels—from the stems to the leaves—form interlacing spherical shells. Assuming that these spherical shells are more or less regularly "interspersed" with norms the volume of each single spherical shell represents at least a rough scale for the quantity of information to be coped with on the respective level.

It is evident that the innermost spherical shell (= total of the "stems") has a far smaller volume than the outermost one (= total of the single "leaves"). Comparing the masses of information derivable from the volumes of the individual spherical shells the quantity of information will understandably show an explosive rise from "inside" to "outside". The more subtle a single article (a law, a legal order as a whole) is subdivided the more powerful the quantities of information and, consequently, also the cost of the system will rise.

3. The zone of collapse

a) Deluge of norms and its consequences. In the reverse case it cannot be assumed that with an increasing refinement also the advantage will be rising likewise. It must rather be supposed that the latter with growing density of information will first of all be increasing progressively and subsequently still linearly, but finally will be declining and later on even petering out. Somewhere the curves of advantage and cost would be crossing each other. From this critical point onward a condition will be reached in which the system will collapse. This condition will be characterized by the fact that the entire expenditure of regulation will be increasingly exceeding the advantage of regulation.

The mentioned expenditure of regulation would in this case gradually degenerate into an "explosion of information" in the form of a deluge of norms that not even jurists would be able to cope with. Already many years ago it has been worked out that it would, e.g., take an Austrian jurist 47 hours per week just to read the annual increase in federal law, i.e., not to study nor possibly memorize it. In order to illustrate the dimension of this deluge of norms it may be added that the Austrian Official Bulletin (= Bundesgesetzblatt, BGBl) as late as 1950 comprised only 1094 pages whereas in 1993 it amounted to 8548 pages (HAUSMANN 1995, p24). That means that the legal order is getting more and more detailed, complex and obscure.

In 1990 the Austrian Constitutional Court (= Verfassungsgerichtshof) repealed a passage of an administrative ordinance (= Verordnung) with the argument that its unintelligible formulation contravened the constitutional postulates of legal clarity and legal security to such an extent that it could not even guarantee a "minimum of comprehensibility", pointing out in particular: "Only with subtle expert knowledge, extraordinary methodical proficiency and a certain inclination for resolving brain twisters it may be understood what orders shall be issued here" (Quotation according to LAMMER 1995, p76). A renowned expert of public law and judge of the Constitutional Court recently stated tersely: "The situation of our legal order has truly become unbearable as far as the principle of the rule of law is concerned. A legal order is given up by itself if it is no more possible for the legal subjects to find out with a reasonable expenditure of energy what is lawful" (KORINEK 1995, p237).

The situation appears to be no better in other countries. An instructive survey has recently been composed by LAMMER (LAMMER 1995a, pp93ff). On the so-called "Bonn law fabrication" some time ago a well-known German news magazine[1] has written as follows: "In ever shorter intervals worse and worse laws are falling from the conveyor belt. In the past ten years 122 amendments regarding the most important tax laws have been enacted. The income-tax law has been amended during this decade 64 times, since 1988 alone 31 times". Article 10 lit.e of this German income-tax law would be "only one out of numerous articles that may be seen through merely by a few specialists. The Association of German Fiscal Judges is complaining of 30 involved and hardly intelligible single phrases". Since its entry into force in 1987 this law had been furthermore 5 times amended by the legislator and 33 times "interpreted about" by decisions of the Federal Fiscal Court.

According to the estimation by the former president of the European Commission DELORS approximately half of all German laws were occasioned by European Union acts (LAMMER 1995a, p131f). As everybody knows it is just the law of the European Union that suffers "from diseases which are also typical of national law. There is first the deluge of law; for instance in 1987 alone about 4200 new E.C. regulations (= Verordnungen) were enacted..." (HELSPER 1989, p231; cf. also KORINEK 1992, p44). The Official Journal of the European Communities in which the legislative activity in the European Union is reflected comprises year after year approximately 20,000 pages (LAMMER 1995a, p131): Apart from the much-quoted directives on the curvature radius of cucumbers among other things 71 regulations on sugar complete the norm stock of the European Market Organization (GROLL 1985, p12; Special thanks are due to Dr. HELLER from the Office of the Salzburg Provincial Government (= Amt der Salzburger Landesregierung) for the hint regarding the sugar regulations.). The respective norms for rear-view mirrors of motorbikes, on the other hand, have occupied just 11 pages (GROLL 1985, p12).

Two more examples selected from the Austrian legal order shall illustrate that many norms are increasingly falling out of the horizon of understanding, and this does not only affect laymen but even lawyers who are not experts in the respective field. Their translation has therefore to be rejected in this context:

§ 4 Absatz 4 des österreichischen Mietrechtsgesetzes:

"Nützliche Verbesserungen im Inneren eines Mietgegenstandes bedürfen der Zustimmung des

Hauptmieters; es gilt jedoch § 30 Abs. 2 Z 16, sofern der Hauptmieter einer mangelhaft ausgestatteten Wohnung im Sinn des § 3 Z 10 des Stadterneuerungsgesetzes, die zur Anhebung des Standards nach Abs. 2 Z 4 geeignet ist, das vom Vermieter gestellte Anbot, die zur Abwendung eines Enteignungsantrags nach § 14 des Stadterneuerungsgesetzes erforderlichen bautechnischen Maßnahmen gegen Entrichtung des für die so verbesserte Wohnung nach § 15a Abs. 3 Z 3 berechneten Hauptmietzinses durchzuführen, ablehnt und auch nicht bereit ist, diese bautechnischen Maßnahmen selbst durchzuführen".

§ 5 Absatz 2 des Entwurfes für eine Novelle zum Bezügegesetz:

"Die Nebengebührenzulage zum Ruhegenuß beträgt, sofern dem Ruhegenuß eine Ruhegenußbemessungsgrundlage im Ausmaß von 80% des ruhegenußfähigen Monatsbezuges zugrundeliegt, den 437.5ten Teil des Betrages, der sich aus der Multiplikation der Summe der Nebengebührenwerte mit 1% des im Zeitpunkt des Entstehens des Anspruches auf die Nebengebührenzulage geltenden Gehaltes der Gehaltsstufe 2 der Dienstklasse V zuzüglich einer allfälligen Teuerungszulage ergibt. Liegt dem Ruhegenuß eine gemäß § 4 Abs. 3 des Pensionsgesetzes 1965 gekürzte Ruhegenußbemessungsgrundlage zugrunde, so gebührt die Nebengebührenzulage in jenem Ausmaß, das dem Verhältnis der gekürzten zur vollen Ruhegenußbemessungsgrundlage entspricht".

Increasing density of regulation does not only promote the creation of incomprehensible single norms but also the occurrence of other legal shortcomings and contradictions. In 1996, e.g., the Austrian legislator being under pressure of time adopted a so-called "economical package" (= Sparpaket). It was composed of a "Structural Adaptation Act" (= Strukturanpassungsgesetz) interfering among other things with approximately 100 federal laws in force. On the last day of the session before Easter all the corrections contrary to the government bill had to be speedily adjusted in the budget committee. In order to save time neither the texts of the motions were read nor the laws affected by them were quoted. The members of parliament were inevitably groping in the dark. 250 votes were thus being performed within 90 minutes.[2] A participant pointed out: "I am convinced that there is no member of parliament capable of reconstructing all 98 amendments just in principle". Someone else put it more drastically: "Parliamentarism has been slain by 12.4 kilograms of paper".[3]

Not only laws, however, but also administrative ordinances (Verordnungen) or ministerial orders (Erlässe) contribute their share to the deluge of norms. The Austrian universities, for instance, were confronted in 1991 with a ministerial order of 17 pages[4] regulating the so-called "career talk" that superiors had to conduct with assistants periodically. This order deals with seven topics in detail:

A. Whom does the career talk apply to?
B. Who is obliged to conduct the career talk?
C. When has a career talk to be conducted?
D. The career talk has to be conducted provably.
E. Who is authorized to look into the protocol that has to be deposited in the personal file?
F. Topics of the career talk.
G. The career talk is a tête-à-tête.

As already mentioned, all this extends in detail over 17 pages.

A scarcely less overzealous "Regulation for the Workshop at the Faculty of Natural Sciences" (First version approved by the Federal Ministry for Science and Research (= Bundesministerium für Wissenschaft und Forschung) on 4 January 1989, file no. (= GZ) 70.409/28-14/88; first modified version approved by the Federal Ministry for Science, Research and Art on 19 Dec. 1995, file no. 71.505/23-I/A/3/95, published in the Bulletin (= Mitteilungsblatt) of the University of Salzburg for the academic year 1995/96, 20. Stück, Nr. 132, 18 March 1996) of the university of Salzburg states in its Art. 4 para 7: "During the performance of the work those contacts necessary for the orderly execution of the shop order have to be maintained between the foreman of the workshop, the skilled worker and the orderer".

Giving a more detailed executive decree as for whether this contact should be performed in writing, by word of mouth, by telephone or by fax, or possibly regarding its frequency, length of time, loudness level or perhaps language, was however refrained from in the end.

It is more or less evident that a meticulous regulation of the administrative activity at universities will not remain without consequences. Also university professors can be burdened with the study of many detailed regulations and with other administrative duties to an extent that may at the worst paralyze their essential tasks for some time.

No less disquieting is another concomitant phenomenon of the deluge of norms. Even jurists, quite apart from other persons applying legal norms, are increasingly faced with situations where they cannot see "the wood for the trees". They may then be similar to a postman who does meticulous-

ly memorize the inmates of any house as well as the street names but does not realize he is in the wrong town.

An investigating magistrate of an Austrian Regional Court (Landesgericht), for instance, issued a search warrant. Against this act of jurisdiction the tenant affected filed a suit for disturbance of possession against the Republic of Austria represented by the president of the competent Regional Court. According to reliable reports it was not easy for the president of the Regional Court who had been summoned as the exponent of the defendant to make it clear to the zealous civil court judge that the latter—to apply once more the previous metaphor—had certainly found the "right inmate" but at the same time got lost in a "wrong town". Supreme court decisions illustrate that similar misunderstandings obviously do occur not infrequently.[5] If now and then even judges overwhelmed with the deluge of norms cannot see anymore "the wood for the trees", and suffocated with detail knowledge are no longer capable of distinguishing public law and private law, how should just a non-jurist get along in such a confusing thicket of norms?

Clear legal orders are like a plain compass that enables an at least rough orientation in an unknown terrain. With an increasing deluge of norms this compass seems to get lost. The confused addressee of norms virtually loses his way among the many trees of a wood the structure and dimension of which must often remain concealed to him.

The increasing deluge of norms does not only overtax the limited information processing capacity of the citizen but also his emotional ties with "his" law. WASSERMANN was quite right when regretting some time ago that "more laws" mean "less abiding by the law". The increase in law production would simultaneously cause an "erosion of the legal consciousness", the laws would "to a large extent forfeit their power over consciousness" (WASSERMANN 1994, p13f). And the fact that from a certain "saturation point" onward "more and more acts will be producing less and less law" has meanwhile become already a "standard phrase of nomology" (LAMMER 1995, p85; cf. also MANTL 1995, p38f; GROLL 1985, p142f; cf. also MAYER-MALY 1969, p81).

b) The contribution of jurisprudence. Legislative over-zealousness as such would already lead to an aberration which in the case of persistent continuation could only end as in the past the building of the Tower of Babel. Jurisprudence among other things undergoes the Sisyphean task to explore by means of assiduous and perspicacious analyses the questionable contents of innumerable single elements of the legal order. By this certainly laudable undertaking, however, not only clarity in individual cases is sought (and frequently also found). All these efforts as a whole keep at the same time the deluge of information exploding.

Two little examples may—pars pro toto—illustrate this:

An assistant at the Institute of Public Law of an Austrian university became a witness of an incident described by himself as follows (LUKASSER 1994/95, pp185ff):

"Dani gives a students' party in his spacious flat. When around 2 o'clock in the morning two fans of the British music underground take over the control of the stereo set it becomes definitely loud. A neighbor who finds it too loud calls the police.

When two officers of the Federal Police Department (= Bundespolizeidirektion) ring at the door of the apartment nobody hears that. One of the visitors just happens to leave and opens the door from the inside. The officers enter—friendly greeted by some party visitors (among them also the author) standing by the door and no more capable of drawing the right conclusions from the green garments of the new arrivals—with astonishing purposefulness the room where there is the stereo set.

There they note down Dani's particulars, admonish him to turn the set down to moderate volume and to maintain this sound level and explain to him that they might otherwise possibly 'take away the set'. The officers behave politely, yet firmly; (the householder) is polite, but frosty".

After the officers had left the householder, among other things, raised the question if the policemen were simply allowed to enter his apartment. This legal problem inspired the author to compose a jurisprudential essay comprising more than six pages (DIN A4) with 49 footnotes. Eight of these footnotes have 10 and more lines, the most comprehensive one amounts to 21 closely printed lines.

A professional colleague of this author even analyzed on over 18 printed pages primarily the question if and under what circumstances conductors were authorized to take fare dodgers into custody. Almost one third of the printed paper is made up of 194 footnotes with most detailed indications of, e.g., specialized literature and the relevant special jurisdiction of the supreme courts. 24 out of these footnotes comprised ten or more printed lines, among them being even 7 footnotes with 20 or

more lines "led" by an annotation totalling 76 printed lines (ZELENY 1995, pp560–578).

It shall not at all be doubted that both topics—viewed from the jurisprudential standpoint—were "worth" the outlined quantity of information. Legal experts with still more meticulosity would certainly be able to treat the respective legal problems in a still more comprehensive and profound manner in thick monographs. However the serious question arises if these (and many similar) analyses were not apt to become ultimately an end in itself. They are not even fully useful anymore for members of specialized senates of the Administrative Court: the judges of this Court may—provided that they have the time required for it—after carefully studying such specialized literature know finally what is lawful: But when deciding such cases may they take for granted that, for instance, also plain patrolmen or tram conductors have to study at length the relevant material prior to entering a flat or taking a fare dodger into temporary custody? It shall not at all be discussed here what knowledge in this respect would have to be expected of fare dodgers regarding the power of the conductors.

Already the history of law teaches us that the achievements of jurisprudence have not always been evaluated by the governing classes in an exclusively positive manner. Quite a few historical laws contained prohibitions of interpreting and commenting (RÜPING 1991, p67; ENGISCH 1977, p106f, 93 with further references). Karl ENGISCH apostrophized them with justification as "monuments of legislative naivete" (ENGISCH 1977, p93). However this must not prevent us from reflecting on the scientific and social usefulness of the top refinement of many a juristical work. For the Roman Law the principle was still prevailing: "The solutions offered by jurists should primarily serve to provide judges with standards for judgements" (RAINER 1997, p6). This pragmatic purpose of jurisprudence seems to disappear more and more from its sight. To put it in a parable: He who offers to a physician (or perhaps to a medical layman) methods of measuring that can take someone's temperature with an accuracy of some thousandths degrees is no more useful for medical science. He promotes then his specialized discipline nothing but for its own sake.

4. Normative elements as "factors of elasticity"?

On the whole it always becomes evident that neither too general nor too precise notions are useful in law. The "lex artis" of jurists does not only consist in the capability of finding the "golden mean" between both—impracticable—extremes. In the evolutionary process of legal life an additional strategy of processing has proved advantageous and frequently even unrenouncable: In spite of all efforts regarding the concretization and precision of any single norm an exactly descriptive presentation of the will of the legislator may turn out to be either impossible at all or at least very unsuitable. In such cases the will is usually paraphrased by means of evaluating (= normative) notion elements. Accordingly normative notions act more or less as "factors of elasticity" within an otherwise very rigid and inflexible system of notions.

Law requires, e.g., of parents to look after their children. "Children" may be still babies or already persons just under the age of maturity. How should, however, such duties of parents be sufficiently outlined in a few brief sentences without having recourse in the most common way, e.g., to some *"according to age and maturity"*–clauses as for the nature and intensity of this parental custody?

Not considerably more precisely may the legislator outline how, for instance, the quantity in figures of an *"appropriate"* pecuniary maintenance shall be determined which has to be paid by a certain couple to a certain child.

The concretization of the respective will is anyhow for each single case incumbent on the addressee (and applier) of the legal norm himself. It is obvious that an uncritical application of such—undoubtedly "selection–approved"—factors of elasticity in law may become a problem also on the part of itself. Not everything can be regulated actually—much less in an optimal manner—by means of elastic or general clauses. Nevertheless a moderate application of such elements could help to dam up the sketched deluge of norms here and there at least a little.

5. Ambivalence of the addressees of legal norms—evolutionary explanation

The simple connection between—desired—density of regulation on the one hand and all—undesired to disquieting—consequences of a deluge of norms on the other hand is rarely recognized in everyday life and not at all always taken into account. Addressees of legal norms, and frequently also appliers of law, seem to expect that one and the same system will possess qualities that are plainly incompatible. How often are demanded, for

instance in magazines for consumers, still more perfect regulations on the occasion of single cases lacking satisfactory solution due to loopholes in a law or in legal protection that can never be wholly avoided. Some pages afterwards there will be polemized, frequently by the same authors, against the inflation of laws and their complexity and unclearness.

In this context the speaker (Präsident) of the Austrian Parliament (= Nationalrat) called the permanent demand for less laws—literally quoted—a "hypocrisy". In proof of that he pointed out that in June 1995 alone referring to 373 facts there were 1428 calls for legal regulations. These calls came from government members (11%), from parliamentarians (24%), from other politicians (19%), from journalists (12%), from bodies representing interests (16%) and from other institutions (18%). In the same period the Austrian parliament adopted "only" 15 new laws.[6]

The just mentioned fundamental contradiction seems to be connected at least also with our genotype. EIBL-EIBESFELDT refers to the fact that we have passed 98% of our history as paleolithic hunters and gatherers and possibly therefore have not even genetically processed the neolithic revolution, the changeover to agriculture and stock-farming. By no means we seem to have been able to cope with the still much more recent technical revolution (velocity!) (EIBL-EIBESFELDT 1994, p50). And the like applies, no doubt, also to the process of cultural evolution initiated by the fact that man began to write down rules for living together with others. The approximately 4000 years since then are an extremely short space of time in the context of evolutionary process. The intellect of the homo sapiens is still adapted to paleolithic "medium dimensions" which he may perceive with his own senses. He does not have the makings of comprehending the behavior of complex social systems (MOHR 1987, pp28ff, 104; BARASH 1981, p230; EIBL-EIBESFELDT 1990, p52f; HELSPER 1989, p66). As "short-term optimizers" (KOTRSCHAL 1995, p303) we also seem to be lacking something like a "social long-range sense". We certainly did not need it at that time. Therefore obviously we don't even realize among other things the contradiction between the wish for perfect and complete regulation on the one side and the *simultaneous* desire for a plain and clear legal order on the other side. In reality even from the best legislator may not be expected more than a compromise which in most cases won't be really satisfactory for anybody.

III. Other system qualities of law

1. Biological and "juristical" dummies?

It has already been shown above why and how both in biology and law complexity has to be reduced when processing information. This ingenious processing technique also has a reverse: the search program of the ticks for their prey which as such is ingenious and operates very reliably may of course also be "outfoxed". Somebody could, e.g., warm up a metal plate to 37 degrees and spread it with butyric acid. Ticks which are "taken in" by this "dummy" of a prey would even have to die of starvation under certain circumstances. In the reverse case really existing prey could be manipulated with fever injections in such a way that it would not be recognized anymore in that capacity by the search program of the tick. In nature there are plenty of examples for such "attempts of deception" in this or that direction. They are described, as is generally known, as "mimicry". Biology defines mere (optical, acoustical, olfactory etc.) signals (or combinations of signals) without the contents attached to them (what is "really intended") as "dummies". With them may be alternatively triggered, for instance, aggression, brood care, mating behavior etc., though there does not exist any "real" enemy, any cub or any sexual partner. Comparable patterns of behavior may frequently be observed also in the field of law. Also its "search programs" may be deceived by suitable "dummies":

Law recognizes, for instance, individuals living in a certain form of long-term sexual, economical and flat-sharing community as "spouses" only in case and as long as a specific formal contract (marriage) has been concluded (and remains in force). The existence of this contractual relationship produces certain legal effects. A foreigner, for example, who marries a national resident will usually obtain at least a residence permit in the latter's country. This may sometimes entail "fictitious marriages": foreigners "marry"—for the most part on payment of a correspondingly high remuneration—pro forma a domestic "partner", e.g., with the exclusive intention of obtaining a legal residence or employment permit in the respective country. The "intrinsic" core of this contract, i.e., the marital community of life, is not at all intended and remains strictly excluded. One could assume with certain justification that in such cases the respective aliens' registration office has been deceived by mere "juristical dummies".

Also other "juristical dummies" are used again and again: in many overcrowded cities a parking licence is only issued to citizens having their "main domicile" (Hauptwohnsitz) there. Sometimes the mere registration form is a sufficient proof for that. In other cities the registration form alone is no longer recognized since it could be too easily misused as dummy. In this case the competent inspection organs of the municipal authorities furthermore have recourse to additional indicators for a "main domicile" (room of one's own? existing furniture? garment of the person concerned? etc.) Of course also more complex search programs may be deceived in principle by suitable dummies, though no more that easily like, e.g., by a mere "fictitious registration".

When some years ago the truck transit through a few Austrian provinces (Bundesländer) was reduced for environmental reasons an exception had of course to be provided for the freight enterprises domiciled in the area of the transit routes. The juristical criterion for an exemption permit was the existence of "business premises". This has lead to the result that many foreign enterprises took on lease some green meadows in close vicinity to these routes and supplied them with firms' nameplates, empty equipment chests etc. in order to get a transit permit with these mere dummies of "business premises".

According to reliable reports there is many a registration at the universities not with a view to studying seriously but for the only purpose of obtaining certain discounts (cheaper theatre tickets, train tickets etc.).

Likewise some sects (minimum 15 members) in Poland seem to owe their foundation only to the fact that their "believers" save themselves the import duty for cars of 70 per cent of the purchase price.[7]

Already these few examples reveal that the—necessarily plain and imperfect—operational definitions of the legislator actually may be duped as easily as the search program of the ticks with its similarly simple structure. In this context one may think also of the common phenomenon of—legal—"circumvention of law". The well-known information theorist Karl STEINBUCH has rightly pointed out in this connection some time ago that it is easy "to mock at… juristical definitions, but difficult to regulate social life without them" (STEINBUCH 1978, p64).

Of course attempts of deception do not always result in success, neither in biology nor in legal life. A Swabian baker was put off by the fact that he, as distinguished from service-station attendants, was not allowed to sell bread on Sundays. Without further ado he had installed an e-filling station close to the shop. This was primarily of use to his father who needs an electric wheel chair. Referring to this "electro filling station" he informed the authority that henceforth he would no longer run a bakery but a filling station with integrated baker's shop. According to further reports the chief burgomaster, however, did not fall for this juristical dummy.[8]

2. Selection pressure

Nature now and then develops spontaneously mutations of genotype. Qualities newly originating therefrom improve—or impair—the chances for existence of the mutant in a likewise continually changing environment. Also law as the product of cultural evolution may be interpreted as an organism which continuously has to adjust itself to its social environment in order to be able to "survive" and avoid "ruin".

The particular "social selection pressure" by newly arising regulation deficiencies can—and must—be compensated by incessantly new steps of adaptation. Contrary to the "trial–and–error–process" of biological evolution the process of cultural evolution enables rationally planned purposeful "mutations" in the form of new laws or amendments of already existing laws. So, for example, the Austrian Common Social Insurance Code (Allgemeines Sozialversicherungsgesetz = ASVG) has been amended more than 50 times since its passing in 1955. Of course also the repeal of obsolete laws forms part of this continuous, never ending process of adaptation.

3. Ignorantia iuris nocet?

A much quoted Roman legal proverb said "ignorantia iuris nocet (cf. e.g., MAYER-MALY 1969, pp54ff) (or non nocet)". That is to say that ignorance of the law—at least as a rule—is irrelevant. A trespasser has to reckon with prejudicial consequences in principle also in case he did not know the infringed norm—maybe even provably. This principle which is observed almost without exception has nothing to do with "stubbornness" or "unworldliness" of the appliers of law.

The specific treatment of legal ignorance of addressees of norms by the individual legal orders seems to be explicable rather by evolution, quasi as a "strategy of survival" of these orders. Empirically it is of course known—and recognized—that even the knowledge of norms on the side of academically trained jurists meets and has to meet with certain—and relatively narrow—limits. How much legal

knowledge may (can? must?) one expect from a layman? In any case it will never be possible that the extent of the actually existing legal knowledge alone may decide on the question of juristical application. A legal order would thus give up its basis of existence. It would then be up to each addressee of norms to prevent a norm from being applied to his case just because of its actual (or only pretended) ignorance. A legal order is therefore forced merely for the sake of its own efficiency to apply certain fundamental rules to any individual also in case the latter did not or could not at all know it. Who wants to participate in a highly differentiated social system has to learn at least certain minimum rules of living together. A driver who does not know that he has to stop at a "red" traffic light does not deserve any indulgence. Things may be different with highly complicated and casuistical saving clauses of tax law. Therefore the decision in what cases knowledge of norms has to be presumed by a legal order and under which circumstances legal ignorance may appear excusable will always remain a delicate balancing act between obligation and ability.

4. Conservativeness—"evolutionary blind alleys"

Legal orders are generally considered to be rather "conservative". Their creators take into consideration—at the best—developments of the near future that are still foreseeable for them. To put it evolutionarily: They can yield only to such a "social selection pressure" as may be actual at the time. Clairvoyance is not their affair. How (and why?) should the authors of a civil code from the beginning of the 19th century worry about problems of liability concerning dangers arising from the operation of nuclear power stations which could come into being as late as about one and a half centuries afterwards? Consequently it must be expected that most of the laws lag behind social reality to a certain extent. One may regret this, but everything else would be—at least—"evolutionary luxury".

Not only the character of law but also that one of jurists is generally associated with the notion "conservative": Their inclination to keep to the proven (or also allegedly proven) state of affairs when executing legal norms may be attributed, however, not as much to a hereditary or acquired characteristic as rather to continuously confirmed professional experience. This experience shows, among other things, that any experimenting in the field of law is not only time-consuming and complicated but, furthermore, also often risky. In the reverse case a jurist may—apart from exceptions—scarcely do the wrong thing as long as he keeps to the beaten (and, consequently, generally proven?) track.

As a rule this strategy of caution is advantageous, but at the same time of course antiprogressive. The lacking fondness of experimenting may occasionally even end in "evolutionary blind alleys", that means in the field of law strategies of solution that either were never appropriate or have become obsolete at least in course of time.

This shall be illustrated by a few examples:

Petitions to Austrian real-estate register courts (Grundbuchsgerichte) had to be arranged at all times in a quite specific external form which was passed on from generation to generation without any discussion. As has revealed the study of the historical materials it was just this external form which enormously facilitated the routine handling of petitions by the real-estate register officers as long as their registers were still written by hand. With the changeover of the register system to electronic data processing the original functionality of this specific arrangement has become obsolete for a long time. Nevertheless from habit the respective petitions have been arranged frequently still in the same way "as it always has been done".

Or: from time immemorial it has been regarded in Austria—in law and in legal practise—almost as a "dogma" that representing an absent person in court requires the submission of a formal written power. The reason given for this formalism was the danger of abuse by pretending power of attorney. A "stroke of the pen" of the legislator has reformed Art. 30 of the Code of Civil Procedure (Zivilprozeßordnung = ZPO) in 1983 to the effect that at least for lawyers (Rechtsanwälte) or notaries (Notare) the mere reference to their power (granted in writing or orally) is now sufficient (BGBl 1983/135). This simplification has proved to be good. Misuses have not been reported.

Even more unthinkable was considered in Austrian legal practise the granting of enforcement of pecuniary claims without previous submission of their legal basis, the so-called "title for execution" (e.g. final and enforceable judgment of a civil court) by the prosecuting party. Since the entry into force of the amendment to the Enforcement Code (Exekutionsordnung = EO) of 1995 the enforcement of pecuniary claims not exceeding 100,000 Schillings may be granted under certain circumstances also without the submission of the title for execution. Against abuses there are, of course, appropriate liability reg-

ulations provided for (BGBl 1995/519). Also this simplification—some time ago still more or less unthinkable—seems to have proved successful.

The "conservative character" inherent in law bears indeed a Janus-face: on the whole it seems to be just "necessary for survival" of the system. At the same time, however, it involves that in addition to necessary elements also antiquated and obsolete customs are being handed down to a not inconsiderable extent. Also the development of law as a process of cultural evolution seems to end up now and then in a blind alley.

5. Deluge of norms—lack of "natural enemies"?

It has already been pointed out that the homo sapiens due to his genotype evidently is not able to comprehend complex social systems. This incapacity may be one of the concurring causes of the fact that law as the product of a cultural evolution process lacks an essential system quality. This quality provides for a limitation of the population density in biological systems.

In nature many species compete mutually. The increase of a species favors also the living conditions (and reproduction chances) of their predators. In this way an "ecological balance" develops in the whole system. If in such a system, however, "natural enemies" are missing the "favored" species will go on spreading till this development reaches other limits. The rabbits that have already become proverbial will go on proliferating in such an environment until their propagation will be limited by lack of food. But even if the supply of food remained sufficient in a biotope another mechanism of self-regulation would take effect: an ever more increasing population density would result in growing "density stress" within this species. This in its turn would raise—by hormonal control—aggression and mortality and retard fertility (HAUPTMANN 1993, p13 with further references; cf. also AUBAUER 1996, p127; GEHMACHER 1996, p90). Hence it follows that the population density will always meet with some utmost limit.

A comparison between biological and cultural evolution reveals that law evidently lacks such mechanisms of self-regulation. The almost insatiable need of regulation of man has led so far almost exclusively to a "growth" of norms.

A consciousness of the fact that unbridledly growing "comfort of regulation" has to lead to a collapse of the system seems to be existent only weakly, but certainly not sufficiently effective.

Regulation deficiencies affect the individual obviously more directly and immediately than the rather remote and abstract danger of a collapse of the system. How else could it be explained that till now still no effective instrument for the systematic decimation of the stock of codified law has been developed. All former attempts of repealing obsolete statutes (= Rechtsbereinigung) (cf. e.g., SCHÄFFER 1992, p57f) and aiming at "simplification of law" (= Rechtsvereinfachung) or "deregulation" (cf. e.g., KORINEK 1992, pp31ff) have to appear just miserable measured against the continuous output of the varied social norm production mechanisms. The deluge of norms can—even though sincerely regretted—nevertheless go on raising.

To make matters worse legislation thereby is still equal to a "shot in the dark", at least however to a social macro-experiment the outcome of which is fed back to the control process itself rather by chance and unsystematically (HAUPTMANN 1976, p97).

Some mistakes of the legislator of course lead to corrections. Far more frequently, however, they are only criticized. The like applies to obsolete law. Even voluminous "dead" norm stocks obviously do not really bother anybody. In a word: the homo sapiens apparently failed so far to create in the legal system an institution similar to that one of the "predators" in nature. This system defect certainly has important implications that can be demonstrated also by other processes of a cultural evolution.

In 1995 a great supplier introduced a new E.D.P. operating system almost worldwide. Shortly afterwards the opinion was voiced that another producer had offered the "comfort" of this innovation now being propagated that noisily already in 1989—with even easier operation requirements.

This operating system nevertheless occupied substantially less store capacity.

At least on principle the like should apply to legislation. Accordingly a "good" law would be characterized by an optimal regulation density within the shortest and clearest possible linguistic framework.

A last example—once more taken from traffic law—shall illustrate which possibilities and chances may still lie fallow in the entire legal order. An Austrian traffic club recently compared several textual passages of the Austrian Road Traffic Regulations (Straßenverkehrsordnung = StVO) with analogous German and Swiss provisions. Whereas in the field of "stopping" and "parking" Swiss and German laws get along with 316 and 619 words respectively, the Austrian legislator needs 1550 ones. The regulations

for pedestrians "require" in Austria 638 words, in Switzerland only 305 ones and in Germany no more than 214 words. There is no evidence that the shorter formulations of the latter countries might be insufficient in substance.[9]

This exclusively punctual comparison must not be overvalued of course. Nevertheless it gives an idea of how much "sick" or even "dead" food a potential "predator" could find in the thicket of norms of Austria (and presumably also elsewhere). A critical member of parliament recently demanded the establishment of a parliamentary "simplification office" (Vereinfachungs-Dienst) (FRIESER 1992, pp27ff). If such an office had done its work our legal order would have shrunk to approximately two thirds of its actual volume with the approximately same regulation density. In view of the enormous cost necessarily entailed by a hypertrophically inflated legal system the expenditure for a systematic repeal of obsolete statutes and overall simplification of the norm stock would be comparatively low.

An "ecological balance" would not only have to be established but also to be maintained. The dynamics of evolutionary processes consequently involves that the species "predator" is not likely to die out, also as far as the system of the legal order is concerned: "rabbit-" as well as "norm-populations" would otherwise immediately start again proliferating.

IV. Summary

It could be demonstrated that biological and cultural evolutions (apart from the tradigenetic conveyance of information) are determined by quite similar rules. In both evolutive systems natural limits to information absorbing and information processing unavoidably direct also the degree of simplification and, consequently, of coarsening of each single step of solution.

In the course of a process of cultural evolution over about 4000 years also national legislators in principle came across the same simple "trick" that had been "invented" as strategy of survival already long before, e.g., by the species of the ticks: Both systems have to reduce complexity to a few relevant signals in order to be able to cope with them. This—central—"principle of frugality of signals" is indispensable, however, not only as a "principle of construction" for the respective single articles of a law. This principle of frugality of signals has, moreover, to be taken into consideration also on a large scale. If the dimension of a legal order as a whole shall be adequately recognizable it is impossible to regulate any smallest matter by a separate special law. Modern life in its manifold social, technical and other relations and networks may have become ever so complicated and at the same time the demand for the greatest possible perfection in regulating any thinkable conflict case ever so insatiable, the capacity of information processing has, nevertheless, been remaining quite limited from time immemorial.

No less limited seems to have been remaining the "social long-term perspective" of the homo sapiens: he ignores the basic contradiction between his desire for perfect regulations of all spheres of life and his permanent complaint about a deluge of norms which cannot be handled any longer. It is just logical that he has not yet developed any efficient strategy for limiting this volume of norms so far.

Nevertheless we'll sooner or later have to put up with reducing the whole legal system to substantially less and substantially simpler important rules. In doing so certain inequities due to the necessary "disfinement and coarsening of the law" (MANTL 1995a, p260) will have to be accepted in the interest of the workability of the total order. The dream of a perfect legal order cannot and must not continue. Otherwise, when exceeding a certain degree of complexity, the collapse of the total system of the legal order has to be seriously worried about. It would have to lose largely its behavior regulating and peace securing functions and to degenerate into mere social dice with incomprehensible, no more foreseeable and arbitrary results. This perversion appears to be already existent in smaller branches of our legal order.

Human law has been successful—despite its doubtfulness in particular cases—in canalizing and limiting to a more or less useful extent a just infinite range of behavior of the homo sapiens by means of a comparatively rather limited number of rules. This fact constitutes beyond all doubt an extraordinarily important cultural achievement. Being aware, however, of the weakness of evolutive processes one cannot be astonished at finding them necessarily also in the legal order. It is just the inherent dynamics of these processes that may demonstrate us that human law will always have to remain so imperfect as it has been from the outset.[10]

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Notes

1 Der Spiegel 20/1994, p106f.
2 Profil, Nr. 15, 6 April 1996, pp24ff.
3 Oberösterreichische Nachrichten, 20 April 1996, p3.
4 Bundesministerium für Wissenschaft und Forschung (Federal Ministry for Science and Research), GZ (file no) 4190/22-110 A/91).
5 Juristische Blätter, Jg. 118, Heft 1/1996, pp46ff.
6 Salzburger Nachrichten, 26. Juli 1995, p2.
7 Profil Nr. 52, 23 December 1996, p22.
8 Der Spiegel 13/1996, p54.
9 Profil, Nr. 7/1996, p18.
10 Lecture, given on 30 March 1995 at the Konrad-LORENZ-Institute for Evolution and Cognition Research in Altenberg/Lower Austria. This text constitutes the amplified and revised version of an identical publication which appeared in 1994 in the series "Hoo No Riron" (= Theory of Law, Vol. 14), in Japanese language.
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References

Aubauer, H. P. (1996) Das Verbrauchswachstum der Menschheit. In: Riedl, R./Delpos, M. (eds) Die Ursachen des Wachstums. Unsere Chancen zur Umkehr. Mit einem Vorwort von Dennis Meadows. Wien: Kremayr & Scheriau, pp. 126ff.

Barash, D. (1981) Das Flüstern in uns. Ursprung und Entwicklung menschlichen Verhaltens. Frankfurt/M: Fischer.

Eibl-Eibesfeldt, I. (1990) Der Mensch—das riskierte Wesen. Zur Naturgeschichte menschlicher Unvernunft. 3rd ed. München-Zürich: Piper.

Eibl-Eibesfeldt, I. (1994) Wider die Mißtrauensgesellschaft. Streitschrift für eine bessere Zukunft. München-Zürich: Piper.

Engisch, K. (1977) Einführung in das juristische Denken. 7th ed. Stuttgart, Berlin, Köln, Mainz: Kohlhammer.

Fiala, E. (1990) Soviel Auto braucht der Mensch. Pfäffikon: Eurotax AG.

Fiala, E. (1994) Was nach dem Auto kommt. Freienbach: Eurotax (International) AG.

Frieser, C. (1992) Unsere Gesetzesmaschinerie: "Mit Vollgas im Leerlauf"? In: Neisser H./Frieser, C. (eds) Hilflos im Paragraphendschungel. Eindämmung der Gesetzesflut und Vereinfachung der Gesetzessprache als politischer Auftrag. Wien: Medien und Recht, pp. 23ff.

Gehmacher, E. (1996) Die Politik der Evolution—Die Evolution der Politik. Das Wachstum sozialer Systeme und seine Regulation: Gesellschaftliche Ursachen und Dynamiken. In: Riedl, R./Delpos, M. (eds) Die Ursachen des Wachstums. Unsere Chancen zur Umkehr. Mit einem Vorwort von Dennis Meadows. Wien: Kremayr & Scheriau, pp. 86ff.

Groll, K.-M. (1985) In der Flut der Gesetze. Ursachen. Folgen. Perspektiven. Düsseldorf: Droste.

Haft, F. (1990) Aus der Waagschale der Justitia. Ein Lesebuch aus 2000 Jahren Rechtsgeschichte (2nd ed). München: C. H. Beck/ Deutscher Taschenbuchverlag.

Hauptmann, W. (1976) Möglichkeiten und Grenzen einer modernen Kriminalpolitik. In: Strafrechtliche Probleme der Gegenwart. Strafrechtliches Seminar Ottenstein 1975. Wien: Bundesministerium für Justiz, pp. 91ff.

Hauptmann, W. (1993) Psychologie für Juristen. Kriminologie für Psychologen (2nd ed). München-Wien: R. Oldenbourg.

Hausmann, O. (1995) Gesetzesflut und Rechtskenntnis. In: Der Kriminalbeamte, Official organ of the association of the Austrian C.I.D. officers, pp. 22ff.

Helsper, H. (1989) Die Vorschriften der Evolution für das Recht. Köln: Schmidt.

Helsper, H. (1996) Rechtsordnung und Wachstumsprozesse. In: Riedl, R./Delpos, M. (eds) Die Ursachen des Wachstums. Unsere Chancen zur Umkehr. Mit einem Vorwort von Dennis Meadows. Wien: Kremayr & Scheriau, pp. 247ff.

Korinek, K. (1992) Deregulierung als drängende politische Aufgabe. In: Neisser H./Frieser, C. (eds) Hilflos im Paragraphendschungel. Eindämmung der Gesetzesflut und Vereinfachung der Gesetzessprache als politischer Auftrag. Wien: Medien und Recht, pp. 31ff.

Korinek, K. (1995) Überschaubarkeit der Rechtsordnung als Bedingung für deren Effizienz. Kritische Gedanken zur Situation der österreichischen Rechtsordnung. In: Mantl, W. (ed) Effizienz der Gesetzesproduktion. Abbau der Regelungsdichte im internationalen Vergleich. Wien: Signum, pp. 233 ff.

Kotrschal, K. (1995) Im Egoismus vereint? Tiere und Menschentiere—das neue Weltbild der Verhaltensforschung. München-Zürich: Piper.

Lammer, M. (1995) Grundfragen der Gesetzgebungslehre. In: Mantl, W. (ed) Effizienz der Gesetzesproduktion. Abbau der Regelungsdichte im internationalen Vergleich. Wien: Signum, pp. 59ff.

Lammer, M (1995a) Internationaler Vergleich. In: Mantl, W. (ed) Effizienz der Gesetzesproduktion. Abbau der Regelungsdichte im internationalen Vergleich. Wien: Signum, pp. 93ff.

Lukasser, G. (1994/95) Dani und die Polizei. In: Juristische Ausbildung und Praxis Vorbereitung, Wien: Manz.

Mantl, W. (1995) Aufriß der Problemlage. In: Mantl, W. (ed) Effizienz der Gesetzesproduktion. Abbau der Regelungsdichte im internationalen Vergleich. Wien: Signum, pp. 17ff.

Mantl, W. (1995a) Innovationsimpulse. In: Mantl, W. (ed) Effizienz der Gesetzesproduktion. Abbau der Regelungsdichte im internationalen Vergleich. Wien: Signum, pp. 251 ff.

Mayer-Maly, Th. (1969) Rechtskenntnis und Gesetzesflut, Salzburg: Pustet.

Mohr, H. (1987) Natur und Moral. Ethik in der Biologie. Darmstadt: Wiss. Buchges.

Rainer, J. M. (1997) Römisches Recht. Geschichte und System. Antrittsvorlesung gehalten am 14. März 1996. Salzburg: Pustet.

Rüping, H. (1991) Grundriß der Strafrechtsgeschichte (2nd ed). München: Beck.

Schäffer, H. (1992) Normeninflation und Gesetzesqualität. In: Neisser H./Frieser, C. (eds) Hilflos im Paragraphendschungel. Eindämmung der Gesetzesflut und Vereinfachung der Gesetzessprache als politischer Auftrag. Wien: Medien und Recht, pp. 49ff.

Steinbuch, K. (1978) Maßlos informiert. Die Enteignung unseres Denkens (2nd ed). München-Berlin: Herbig.

Wassermann, R. (1994) Rechtsstaat ohne Rechtsbewußtsein.

Vom Niedergang der Tugenden. In: Fietz, M. /Jach,M.(eds) Zündstoff Kriminalität. Innere Sicherheit auf dem Prüfstand. München: Bonn Aktuell, pp. 10ff.

Wuketits, F. M. (1990) Gene, Kultur und Moral. Soziobiologie—Pro und Contra. Darmstadt: Wiss. Buchges.

Zeleny, K. (1995) Zur Festnahme allgemein und von "Schwarzfahrern" im besonderen. Eine Studie aus öffentlich-rechtlicher Sicht. Österreichische Juristenzeitung. Wien: Manz.

Vladimír Kvasnička and Jiří Pospíchal

Simulation of Evolution of Dawkins Memes

Abstract

The most elementary process of a meme evolution is studied by a combination of feed-forward 3-layer neural network autoassociators and a simple version of genetic algorithm. A meme is represented by a binary string of a fixed length. The whole territory where the evolution is running is divided into compartments, each compartment is occupied by one meme and by one neural network. A meme fitness is determined by activities of hidden neurons that are induced by input activities equal to meme entries. Two different meme transformation processes are studied. The first transformation process is called the copy, where a given meme is simply copied into itself with allowed mutations. We have to emphasize that the used mutations are opportunistic, it means that some of these mutations are affected by the bit value of majority of other memes. The second transformation process is the so-called migration, it consists in a looking for a fittest meme in neighboring compartments. If the fitness of such a meme is greater by a threshold than the fitness of the current meme, then the fittest meme is copied to the current compartment with allowed mutation. If the process of transformation is successively accomplished for all territory compartments, then neural networks are adapted by a prescribed number of epochs with respect to the transformed memes, so that the input would be equal to output. Since the required hidden activities of the 3-layer autoassociator may be realized by various memes, we have observed in our simulation calculations an interesting fact that in the beginning part of evolution many different types of memes arise but then, after some transient period, the number of different memes is substantially decreased and they are well "geographically" separated.

Key words

Meme, simulation, evolution, genetic algorithm, neural network.

1. Introduction

DAWKINS idea of memes (1976) belongs to most controversial concepts of the present evolutionary biology and humanities (BONNER 1980; BOYD/RICHERSON 1985; CAVALLI-SFORZA/FELDMAN 1981; HUTCHINS/HAZLEHURST 1992). After DAWKINS, memes are "ideas, catch-phrases, clothes-fashion, way of making of pots or building arches". He claimed that "just as genes propagate themselves in the gene pool by leaping from body to body via sperms or eggs, so memes propagate themselves in the meme pool by leaping from brain to brain". Computer simulations of meme evolution have been done by HUTCHINS/HAZLEHURST (1992) and by GABORA (1995). These authors demonstrated that by applying a combination of simple versions of feed-forward neural networks and genetic algorithms it is possible to obtain a "microscopic" insight into mechanisms of meme evolution.

Recently, the present authors published two papers (KVASNIČKA/POSPÍCHAL 1999a,b) where an evolution of memes was studied. In the first paper (KVASNIČKA/POSPÍCHAL 1999a) a combination of the BALDWIN effect and memes is studied. It was demonstrated that memes can considerably accelerate the evolutionary process. Difficult behavioral tasks that could not be incorporated into genotype by the BALDWIN effect are shifted to memes. For instance, many different skills and forms of knowledge which increase the number of surviving animals in their struggle for life are of such a complex nature that it is impossible to expect their "canalization" by an evolutionary incorporation to the genotype. These entities may then affect the evolution as "memes"; the fitness of a gene is determined not only by its composition but also by its accompanying meme. In other words, instead of single genes we are talking about a couple composed of a gene and a meme. In the second paper (KVASNIČKA/POSPÍCHAL 1999b) we have studied more elementary problems than in the first one. In particular, we introduced the so-called cognitive artifact represented by a binary mapping and we simulated how a population of neural networks was able to learn this artifact when the evolution was initiated by randomly generated artifacts. We have observed that relatively quickly, after a few tens of epochs, the system was able to learn the artifact so that a few artifact items

were incorrect but their majority was correct. Then the remaining part of evolution consisted in repairing these incorrect artifact items.

An artificial neural network is a computational device, inspired by networks of neural cells in the brain. The subject has been studied since the beginning of this century, and bloomed in the last decade with hundreds of monographs dedicated to it. An artificial neural network used further consists of simple computational units, called neurons, which are highly interconnected. A one-way interconnection transfers a signal (real number) from one unit to another, and multiplies it by a real number called weight, specific for each interconnection. Some neurons called input neurons receive signals from outside; each neuron corresponds to one entry of the input vector. Each of these neurons (constituting input layer) sends signals to a set of so-called hidden neurons; they constitute a hidden layer. The signals which enter a neuron (except for input neurons) are summed, a number specific for each neuron called threshold is added to the sum, then the sum is entered into a sigmoid function, and the resulting output is sent out as a signal into connections outgoing from the neuron. The transformed signals from each hidden neuron are sent to all output neurons (they constitute an output layer). Output neurons send resulting signals outside, their output forms an output vector.

The basic capability of neural networks is to learn patterns from examples. The neural network is given a set of couples composed of input vector together with corresponding desired output vector. The weights of connections and thresholds of neurons are then changed so that an input vector is transformed by the neural network into an output vector as similar as possible to the desired one. The adjustments of weights and thresholds are made incrementally, using the so-called backpropagation learning algorithm. It is actually a gradient descent learning algorithm, where the error based on difference between a desired output and an actual one is used for calculation of a change of weight of connections incoming to the last layer and of thresholds of its neurons. This error is also "processed" or "backpropagated" going in the opposite direction from output to input, and this error processed by one layer is then used for weight and threshold adjustments in further layer. After many cycles, consisting of producing an output from an input and adjusting weights and thresholds according to the error, the network converges to some stable state. When such a learned neural network gets an input similar to the learned one, it is able to give a similar output, which means classifying unknown input patterns. The simple version of neural networks used in our calculations—autoassociators—simply try to produce an output vector identical to an input vector. This task can be performed with various settings of weight and threshold values, even though the input vector may be the same.

The purpose of the present paper is to study the most elementary memetic problem, an evolution of memes for a population of neural networks that are kept attached to their compartment (but their weight and threshold coefficients can be gradually changed) in the course of whole evolution. Computer simulations are performed for memes (binary vectors) that are being "learned" by a population of "brains" represented by autoassociative 3-layer neural networks. These "brains" neither die nor are they born in the course of evolution (except by migration). Nevertheless, though it is postulated that neural networks are kept fixed, they are able to learn, i.e. their weight coefficients may change during the evolution. This change can be different for each neural network.

Neural networks are distributed throughout a territory divided into compartments that are occupied by one neural network and one meme, see Fig. 1. Each meme is evaluated by a fitness determined by activities of hidden neuron of the network from the same compartment. Since the used neural networks are autoassociators, they are trained in such a way that the required output activities are the same as input activities that are equal to the meme from the compartment. The resulting hidden activities are used in evaluation of the meme fitness. Since the required hidden activities of the 3-layer autoassociator may be realized by different memes, one can observe an interesting fact that in the beginning part of evolution many different types of memes arise but then, after some transient period, number of different memes is substantially decreased and they are "geographically" separated.

2. Basic concepts

Let us consider a *territory T* composed of *K compartments* $C_1, C_2, \ldots, C_K$

$$T = \{C_1, C_2, \ldots, C_K\} \tag{1}$$

For each compartment C_i from the territory a *neighborhood* is defined

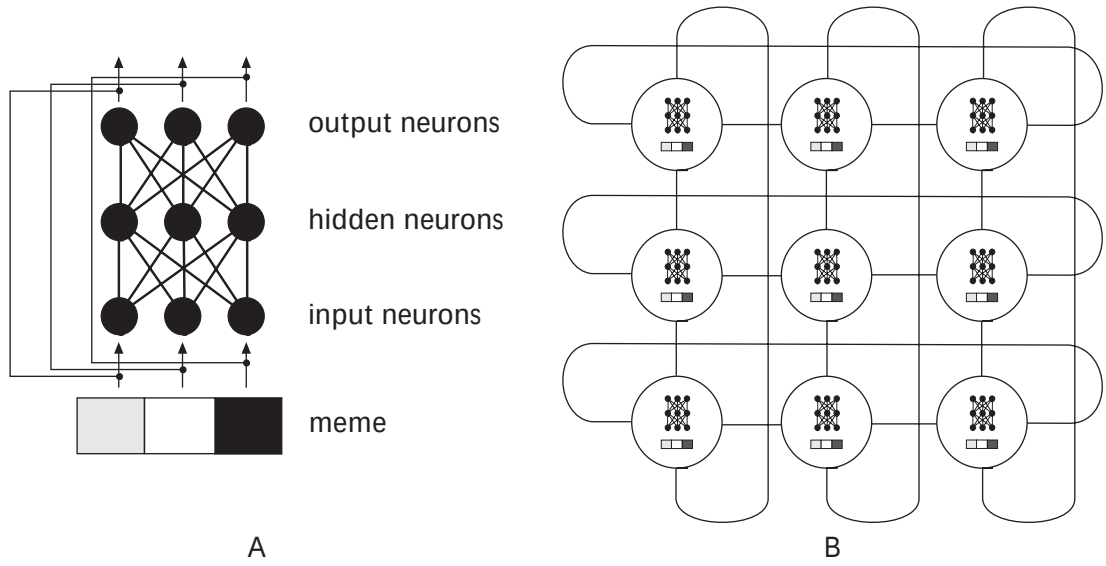

Figure 1. (A) Schematic outline of a couple composed of one autoassociative 3-layer neural network and one meme. An input of a neural network and its required output is equal to the meme entries. Activities of hidden neurons determine a meme fitness. (B) A territory is divided into smaller compartments that are occupied by a couple composed of a neural network and a meme. Memes may migrate, a meme may leap from a compartment to another neighboring compartment. Compartments are placed on vertices of an orthogonal grid that is folded so that boundary columns/rows are directly connected, the resulting structure is called the toroid. The dimension of this orthogonal grid is determined by an integer N, the grid is composed of $N \times N$ vertices–compartments.

$$\mathrm{neighb}(C_i) = \{C_{i_1}, C_{i_2}, \ldots\} \subset T \tag{2}$$

In our forthcoming considerations we use an orthogonal grid (see Fig. 1, diagram B) for a decomposition of the territory T into compartments, each grid vertex corresponds to a compartment. Moreover, a neighborhood of a compartment is composed of all compartments that are directly connected with the compartment by edges on the grid.

Let *NN* be a *3-layer feedforward neural network* composed of *n input neurons*, *n hidden neurons*, and *n output neurons*, see Fig. 2. Activities of hidden neurons as a response to input activities are determined as follows

$$z_i = t\left(\sum_{j=1}^{n} w_{ij}^{(h)} x_j + \vartheta_i^{(h)}\right) \tag{3}$$

where $w_{ij}^{(h)}$ is a *weight coefficient* assigned to a connection outcoming from the *j*-th input neuron and incoming to the *i*-th hidden neuron, and $\vartheta_i^{(h)}$ is a *threshold coefficient* assigned to the *i*-th hidden neuron. In a similar way, activities of output neurons are

$$y_i = t\left(\sum_{j=1}^{n} w_{ij}^{(o)} z_j + \vartheta_i^{(o)}\right) \tag{4}$$

where $w_{ij}^{(o)}$ is a weight coefficient assigned to a connection outcoming from the *j*-th hidden neuron and incoming to the *i*-th output neuron, and $\vartheta_i^{(o)}$ is a threshold coefficient assigned to the *i*-th output neuron.

A *transfer function* $t(x)$ appearing in the above relations (3, 4) for hidden and output activities is determined as a sigmoid (logistic or squashing) function

$$t(x) = \frac{1}{1 + e^{-x}} \tag{5}$$

Its first derivative is determined by $t'(x) = t(x)[1 - t(x)]$.

The above 3-layer neural network may be formally considered as a parametric function that maps the vector of input activities $x = (x_1, x_2, \ldots, x_n) \in R^n$ onto the vector of output activities $y = (y_1, y_2, \ldots, y_n) \in R^n$, where the vector of hidden activities $z = (z_1, z_2, \ldots, z_n) \in R^n$ plays in the performance of mapping only a role of an intermediate (hidden) result

$$NN(w^{(h)}, \vartheta^{(h)}, w^{(o)}, \vartheta^{(o)}): R^n \to R^n \tag{6a}$$

or in an explicit form

$$y = NN(x; w^{(h)}, \vartheta^{(h)}, w^{(o)}, \vartheta^{(o)}) \tag{6b}$$

Let us specify the neural network as an autoassociator, i.e. it is required that the input and output ac-

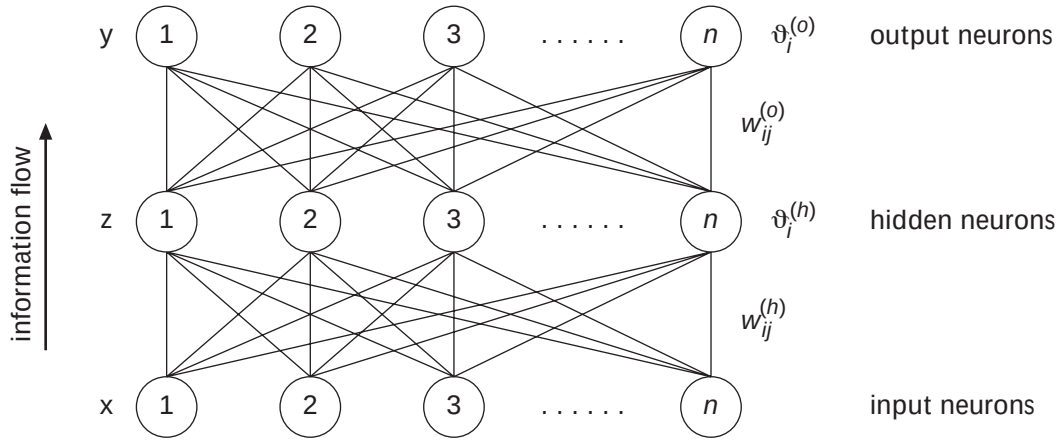

Figure 2. Three-layer feedforward neural network composed of the same number of input, hidden, and output neurons. Juxtaposed layers (input–hidden and hidden–output) are fully connected by upward oriented connections.

tivities be the same. An *adaptation process* of such a neural network consists in a systematic tuning of weight and threshold coefficients so that the calculated output activities y (as a response on the input activities x) are equal to their required output activities $y^{(\mathrm{req})} = x$. For the adaptation process we need the so-called *training set* composed of input activities

$$A_{train} = \{x_1, x_2, \ldots\} \tag{7}$$

The adaptation process is equivalent to a minimization of the objective function

$$E = \frac{1}{2} \sum_{x \in A_{train}} (y - x)^2 \tag{8}$$

It describes a measure of deviance of the calculated output activities from the required ones, i.e. from the input activities. Its function value is always nonnegative; if it is vanishing, then the calculated output activities are equal to the corresponding input activities, which was to be achieved as a result of the adaptation process.

The minimization process of the objective function (8) can be performed by the standard gradient steepest descent method, i.e. weight and threshold coefficients are recurrently updated by

$$\begin{aligned}
w_{ij}^{(o)}(k+1) &= w_{ij}^{(o)}(k) - \lambda \frac{\partial E}{\partial w_{ij}^{(o)}} + \mu \Delta w_{ij}^{(o)}(k) \\
\vartheta_i^{(o)}(k+1) &= \vartheta_i^{(o)}(k) - \lambda \frac{\partial E}{\partial \vartheta_i^{(o)}} + \mu \Delta \vartheta_i^{(o)}(k) \\
w_{ij}^{(h)}(k+1) &= w_{ij}^{(h)}(k) - \lambda \frac{\partial E}{\partial w_{ij}^{(h)}} + \mu \Delta w_{ij}^{(h)}(k) \\
\vartheta_i^{(h)}(k+1) &= \vartheta_i^{(h)}(k) - \lambda \frac{\partial E}{\partial \vartheta_i^{(h)}} + \mu \Delta \vartheta_i^{(h)}(k)
\end{aligned} \tag{9}$$

where λ is a small positive parameter called the *learning rate* and μ is a positive parameter called the *momentum rate*. (References of detailes for the interested readed can be found in HAYKIN 1994, pp138–156). The last terms in (9) correspond to the so-called *momentum terms* that are determined as differences of coefficients from the last two iterations, e.g., $\Delta w_{ij}^{(o)}(k) = w_{ij}^{(o)}(k) - w_{ij}^{(o)}(k-1)$. These momentum terms might be important in initial stages of an adaptation process to escape local minima.

The partial derivatives of the objective function E with respect to the threshold and weight coefficients are simply determined in such a way that in the first stage we calculate them for output neurons and then for hidden neurons. In the literature this method of calculation of partial derivatives is called *back propagation* (HAYKIN 1994).

$$\frac{\partial E}{\partial \vartheta_i^{(o)}} = y_i(1-y_i)(y_i - x_i), \quad \frac{\partial E}{\partial w_{ij}^{(o)}} = \frac{\partial E}{\partial \vartheta_i^{(o)}} z_j \tag{10a}$$

$$\begin{aligned}
\frac{\partial E}{\partial \vartheta_i^{(h)}} &= z_i(1-z_i) \sum_{j=1}^{n} \frac{\partial E}{\partial \vartheta_j^{(o)}} w_{ji}^{(o)} \\
\frac{\partial E}{\partial w_{ij}^{(h)}} &= \frac{\partial E}{\partial \vartheta_i^{(h)}} x_j
\end{aligned} \tag{10b}$$

These formulae are satisfied only for one input activity vector from the training set A_{train}. For a whole training set the partial derivatives are simply determined as a sum of partial derivatives determined by (10a–b) calculated for all input activity vectors.

The adaptation process is finished if the following condition is not satisfied:

$$k < k_{max} \tag{11}$$

where k_{max} is the maximal number of steps in the adaptation process.

Let us postulate that each compartment C_i of the territory T is occupied by one neural network NN_i and a *meme* x_i determined as a binary vector of the length n

$$x_i = (x_1^{(i)}, x_2^{(i)}, \ldots, x_n^{(i)}) \in (0, 1)^n \qquad (12)$$

The adaptation process of the neural network NN_i is specified by the training set composed of one pair of input and required output activity vectors, $A_{train} = \{x_i / x_i\}$, i.e. the required output activity is equal to the input activity. This means that the neural network NN_i is a simple autoassociative memory, it maps the input vector x_i onto the same vector x_i, ideally

$$x_i = NN_i(x_i; w^{(h)}, \vartheta^{(h)}, w^{(o)}, \vartheta^{(o)}) \qquad (13)$$

where the used weight and threshold coefficients are determined by the adaptation process. We have to emphasize that this relation (13) can be realized by many different sets of weight and threshold coefficients. Since neural networks are highly nonlinear mapping devices, the same meme x_i may be produced by (13) in many different ways.

The hidden activities assigned to the input vector x_i create a real vector $z_i = (z_1^{(i)}, z_2^{(i)}, \ldots, z_n^{(i)}) \in \{0, 1\}^n$. In the theory of feed-forward neural networks it is frequently stated that the activities of hidden neurons form the so-called *internal representation* of the input vector x_i, each input pattern (outer information) is internally represented by active hidden neurons. This fact is often applied in cognitive-science applications of neural networks, their hidden activities are used as an internal–mental representation of an object that is represented by input activities. In our forthcoming considerations the vector z_i of hidden activities will be called the *semantic representation* of the input vector x_i, $\mathrm{seman}(x_i) = z_i$.

Let $z_{opt} = (z_1^{(\mathrm{opt})}, z_2^{(\mathrm{opt})}, \ldots, z_n^{(\mathrm{opt})}) \in \{0, 1\}^n$ be an *optimal semantic representation* (a randomly generated binary vector); then the *fitness* of memes on the territory T is calculated with respect to this optimal semantic representation by

$$f(x_i) = f_{min} + (f_{max} - f_{min}) e^{-\xi \left| \mathrm{seman}(x_i) - z_{opt} \right|} \qquad (14)$$

where $f_{\min}$ and $f_{\max}$ are upper and lower bounds of fitness, respectively, i.e.,

$$f_{min} \le f(x_i) \le f_{max} \qquad (15)$$

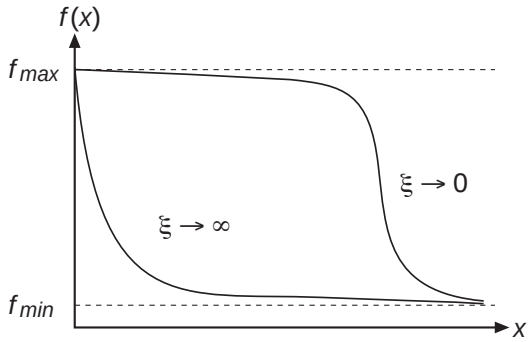

Figure 3. Schematic plots of the fitness function determined by (14) for two asymptotic values of the fitness rate ξ. If the fitness rate tends to infinity, then the fitness function is equal to f_{max} only if the semantic structure of meme x is the optimal semantic structure, i.e., $\mathrm{seman}(x) = z_{opt}$, otherwise the fitness function is equal to f_{min}. On the other hand, if the rate tends to zero, then the fitness function is closely related to f_{max} for an arbitrary meme.

The parameter ξ from (14) determines the so-called *fitness rate*. If this parameter is very small ($\xi \to 0$), then fitness of all memes is the same and its value is equal to f_{max}. On the other hand, if ξ is a large positive number ($\xi \to \infty$), then fitness is equal either to f_{max} (if the semantic interpretation is equal to the optimal vector, $\mathrm{seman}(x_i) = z_{opt}$), or to f_{min} (otherwise) (see Fig. 3).

$$\lim_{\xi \to 0} f(x_i) = f_{max} \qquad (16a)$$

$$\lim_{\xi \to 0} f(x_i) = f_{max}$$

$$\lim_{\xi \to \infty} f(x_i) = \begin{cases} f_{max} & \text{if } \mathrm{seman}(x_i) = z_{opt} \\ f_{min} & \text{if } \mathrm{seman}(x_i) \neq z_{opt} \end{cases} \qquad (16b)$$

3. A simplified form of a genetic algorithm (GA) for the simulation of meme evolution

An evolution of memes will be simulated by a simplified version of a GA (GOLDBERG 1989), see Fig. 4. In our forthcoming discussions the GA's term "population" is substituted by the previously introduced term "territory", which is divided into compartments with specified relationship of neighborhood between them. The term "chromosome" used in GA corresponds here to a couple meme–neural network contained in a compartment. The process of reproduction, which creates a new population P' from the old population P, is specified by two types of meme transformations. We go systematically through all compartments on the territory T, for each compartment we apply either the operation *copy* (with a probability P_{copy}) or the operation *migration* (with a probability $P_{migr} = 1 - P_{copy}$).

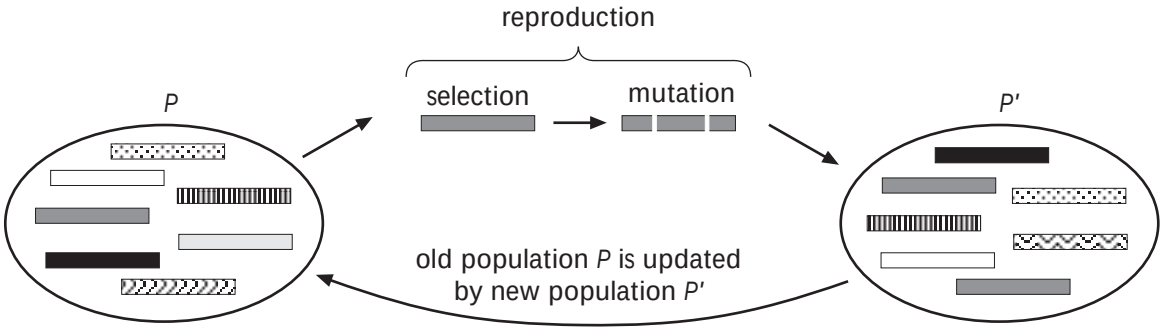

Figure 4. A diagrammatic outline of simplified version of the genetic algorithm (GA). A population P is composed of chromosomes (usually binary strings of the same length) that are evaluated by positive real numbers called the fitness. The fitness is assigned to a quality of chromosomes, better quality means a greater fitness. Applying repeatedly a process of reproduction we create from the old population P a new population P'. The process of reproduction is composed of two subprocesses called selection and mutation. The subprocess of selection means that from the population P there is selected quasirandomly a chromosome in a dependence on its fitness and its position in the territory (fitter chromosomes have greater chance to be selected). The second subprocess "mutation" corresponds to a flipping of randomly selected bit entries (on the above diagram represented by small white columns). The created chromosome is transferred to a new population P'. When this new population is composed of the same number of chromosomes as the old population P, then $P \leftarrow P'$ and the whole process is repeated. The GA is stopped if some convergence criteria are met, e.g., if the population P is very homogenous, i.e., if it is composed of almost the same chromosomes. In this simplified version of GA we did not use the concept of crossover, where two quasirandomly selected chromosomes are mutually exchanging randomly selected bit substrings of the same length. The problem whether the crossover belongs to the most important integral parts of GAs is frequently discussed in the current literature (see FOGEL 1995).

In order to specify these two important notions of our theory we have to introduce in advance the concept of mutation that is not fully random but to some extent opportunistic with respect to a majority of other memes. Let $w = (w_1, w_2, \ldots, w_n)$ be the a probability vector whose components w_i determine the probability of the event that if we select randomly a compartment, then for its meme $x = (x_1, x_2, \ldots, x_n)$ we get $x_i = 1$. For a given distribution of memes $x_i = (x_1^{(i)}, x_2^{(i)}, \ldots, x_n^{(i)})$ over a territory T we set

$$w_j = \frac{1}{|T|} \sum_{i=1}^{|T|} x_j^{(i)} \tag{17}$$

The operator of mutation O_{mut} transforms stochastically a meme onto another meme

$$x' = O_{mut}(x) \tag{18a}$$

$$x_i' = \begin{cases} \tilde{x}_i & \text{if random} < P_{mut} \\ x_i & \text{otherwise} \end{cases}$$

$$\tilde{x}_i = \begin{cases} 1 & \text{if } w_i \geq 1 - \varepsilon \\ 0 & \text{if } w_i \leq \varepsilon \\ 1 - x_i & \end{cases} \tag{18b}$$

where ε is a small positive number called the opportunistic threshold. Inspecting the second relation in (18b) we may explain why in the above comment it was said that the mutation is opportunistic. If the probability entry w_i is greater (smaller) than an opportunistic threshold value closely related to one (zero), i.e. $w_i > 1 - \varepsilon$ ($w_i < \varepsilon$), then we may say that the mutation is opportunistic since it sets the bit entry x_i to the corresponding value of the majority of memes from the territory T. On the other hand, if the probability entry satisfies $\varepsilon < w_i < 1 - \varepsilon$, then the mutation performed over the corresponding bit entry is not opportunistic and simply flips its bit value.

Let us assume that in the course of a reproduction process we visit a compartment C_i that is occupied by a meme x_i and a neural network NN_i. A copy operation applied to the meme x_i consists in copying this meme to the same compartment in a new population and this process is accompanied by the above specified opportunistic mutation. Formally

$$x' = O_{copy}(x) = O_{mut}(x) \tag{19}$$

The compartment's neural network NN_i is readapted (by a prescribed number of steps k_{max}) with respect to this new copied meme x', and we get a neural network denoted by NN_i'. The resulting hidden activities from this readapted network are used for a recalculation of the fitness assigned to the new meme x'. The compartment C_i is updated by the copy operation as follows:

$$C_i' \leftarrow \{ NN_i \leftarrow NN_i' \text{ and } x_i \leftarrow x_i' \} \tag{20}$$

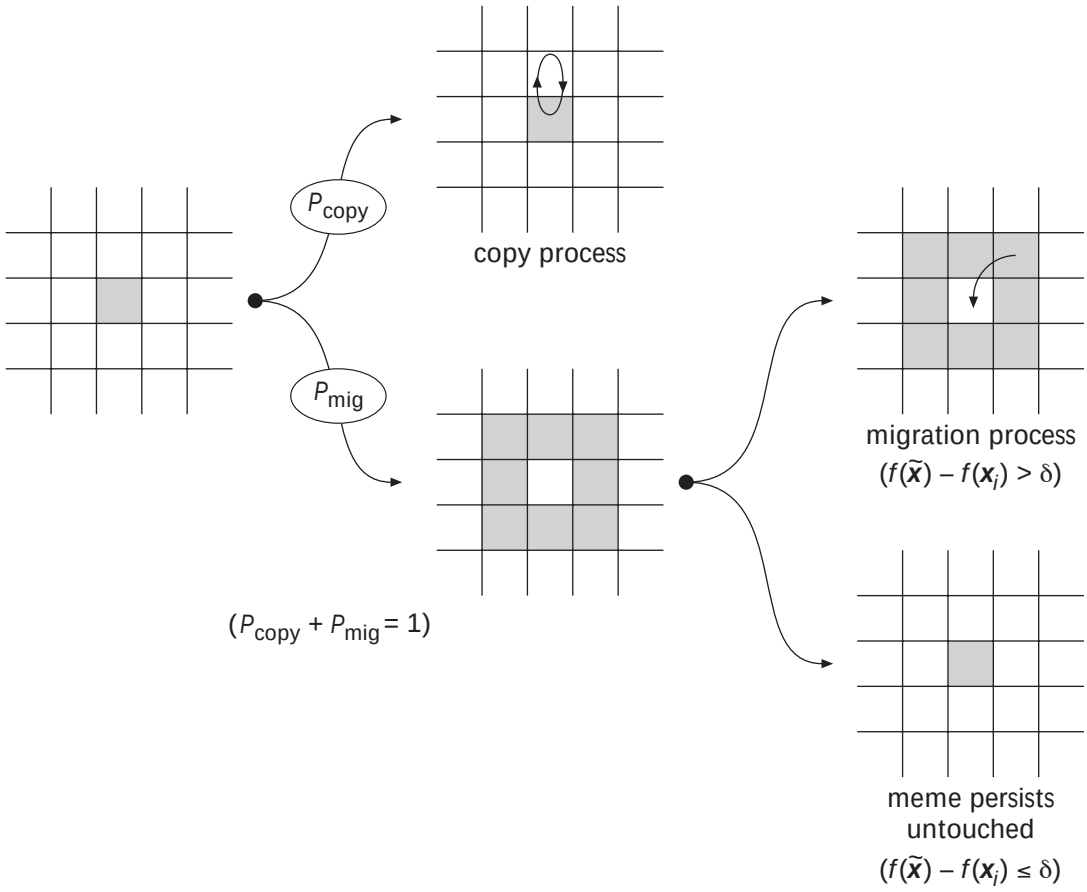

Figure 5. A schematic outline of both meme transformation processes. For the current compartment we select stochastically either the copy process or the migration process. A stochasticity of these processes is determined by the probabilities P_{copy} and $P_{mig} = 1 - P_{copy}$. In the copy process the current meme is copied into itself with allowed opportunistic mutations. In the migration process we look in the closest neighborhood for a fittest meme and if its fitness is greater (an analog of DARWINIAN selection) than a fitness of a meme placed in the central–current compartment, then this fittest meme is copied to the central compartment. The copy process includes an opportunistic mutation process with respect to all other memes. After finishing the copy process the current compartment neural network is re-adapted by the prescribed number k_{max} of steps. On the other hand, if such fittest meme does not exist, then the current central compartment remains untouched.

In the process of *migration*, we look for in all compartments that are neighboring to the compartment C_i whether there exists a meme $\tilde{x}$ with a fitness greater than a slightly increased fitness of the meme x_i placed in C_i, namely, whether $f(\tilde{x}) - f(x_i) > \delta$, where δ is a small positive constant called the migration threshold. If so, then the original meme is substituted by the fittest one and the neural network is readapted (by a prescribed number k_{max}) with respect to this new meme. We have to emphasize that this substitution process is done in the same way as the similar copy process of a meme onto itself, in particular it contains the opportunistic mutation determined by the probability P_{mut}. In the opposite case, if a neighborhood of C_i does not contain memes that are fitter than the original one, the compartment C_i remains unchanged. Let $\tilde{C} \in \text{neighb}(C_i)$ be a compartment with a meme $\tilde{x}$ that is fitter than a slightly increased fitness value of x_i, then the process of migration consists in an updating $x_i' \leftarrow O_{mut}(\tilde{x})$ and in a neural network readaptation (by a prescribed number k_{max}) with respect to x_i'. Formally,

$$C_i' \leftarrow \begin{cases} NN_i' \leftarrow NN_i \text{ and } x_i' = O_{mut}(\tilde{x}) \\ \qquad \text{if } f(\tilde{x}) - f(x_i) > \delta \\ C_i \qquad \text{otherwise} \end{cases} \tag{21}$$

Both processes of copying and migration can be formally expressed by (see Fig. 5)

$$C_i \leftarrow O_{copy}(C_i) \text{ and } C_i \leftarrow O_{mig}(C_i) \tag{22}$$

Let us discuss why we have introduced the migration threshold δ. It may serve as a measure of a discrepancy between fitness of the central meme x_i and fitness of $\tilde{x}$ taken from the neighborhood of the meme x_i. The migration process is done when the fitness $f(\tilde{x})$ is greater than an increased fitness $f(x)+\delta$. This means that if the parameter δ is very small, then migration is automatically done for almost each neighboring meme $\tilde{x}$ that satisfies $f(\tilde{x}) > f(x_i)$. Since the meme fitness (14) is monotonously decreasing (see Fig. 3), an acceptance of the migration process is fully independent of the fitness rate ξ. However, if we use the migration threshold δ, then it may happen that for a small value of the fitness parameter ξ and for a sufficiently great value of the migration threshold δ the frequency of migration events is very small. This fact may be simply explained in such a way that for $\xi \to 0$ all meme fitness are closely related (see eq. 16a), i.e. almost for any $\delta > 0$ for all meme pairs the following inequality is satisfied $f(\tilde{x}) < f(x_i)+\delta$. On the other hand, if the fitness parameter ξ has a greater value, then fitness of memes may vary in a sufficiently great range of values (see eqs. 15 and 16b). This fact means that even for relatively large values of the migration threshold δ there exists a couple of memes that satisfies the migration condition $f(\tilde{x})-f(x_i) > \delta$ and so the migration process may run with a higher frequency.

The detailed analysis of the processes going on during evolution can be found in the Appendix. The most important features which emerge during evolution is a selection of only a few memes, which however undergo slow but steady improvement, and their clustering on a grid into "areas" composed of identical memes.

4. Summary and discussion

Let us suppose, that we have a question concerning an evolution of memes and its detailed microscopic insight. If we would restrict our research methods to classical cognitive science approaches, then we could hardly expect to find a detailed explanation of mechanisms and dependence of evolution on single factors. DAWKINS in his famous book "The Selfish Gene" (DAWKINS 1976) presented the interesting idea that DARWINIAN evolution may be extended from living nature also to world of ideas produced by human brains. In our theoretical approach and computer simulations the DARWIN theory is represented by an oversimplified version of a genetic algorithm without crossover. (In evolutionary algorithms such an approach is called the evolutionary programming; FOGEL 1995.) Since the process of broadcasting of memes runs between human brains, our computer simulations has its algorithmic model realized here by neural networks. A combination of both these concepts of modern computer science—genetic algorithms and artificial neural networks—offers an effective tool for a study of a diverse variety of cognitive tasks and their evolution. The results of our computer simulations can be summarized in a form of the following scenario of meme evolution:

At the beginning of evolution memes for all compartments are generated randomly. Pictorially speaking, each individual (represented by a neural network) created its initial meme randomly. Then neural networks are trained as autoassociators with respect to their memes. The produced hidden activities that correspond to internal representations of the memes are used for the calculation of meme fitness. This calculation is performed in such a way that at the beginning of the algorithm an optimal internal representation (called the optimal semantic representation) is randomly generated and then all fitness values are calculated with respect to this optimal representation. Since our approach is based on the DARWINIAN theory of evolution, we have used the assumption that meme reproduction is based on their fitness, in particular, a greater meme fitness means a greater probability for the meme to be participating in the reproduction. The reproduction process is combined with the so-called genetic drift, i.e. random mutations in the reproduction process are used. This genetic drift is opportunistic, a change of a meme entry is controlled by a majority of other memes. A learning process of neural networks is performed in each epoch of the evolutionary algorithm, it is determined by a number of learning steps. If this number is smaller than a threshold value, then evolution is very small or almost stopped. This means that for the evolution of memes it is a very important ability of brains to learn; its suppression leads to stopping of meme evolution. Neural networks are distributed throughout a whole territory on an orthogonal grid folded into a toroid. Since in the reproduction process we look for a fittest meme in the neighborhood of the given meme to be reproduced, the evolution process gives rise to clusters of the same memes that are well "geographically" structured.

Usually, each cluster contains a few memes with a great fitness while its remaining memes have

smaller fitness. At the end of evolution it is observed that the whole territory is divided into a few clusters that correspond to different memes, all these subterritories–clusters represent a different realization of the same optimal semantic representation. Loosely speaking, we may say that an abstract generic idea is represented by the optimal semantic representation. In the course of meme evolution this generic idea can be filled by different memes that are well "geographically" structured. Such a cluster composed of the same memes usually contains a few memes that perfectly mimic the required optimal semantic representation–generic idea (i.e. they are of great fitness), while the remaining ones mimic weakly the optimal semantic representation (i.e. they are of small fitness). In the course of further evolution this clustering remains relatively stable, only on cluster borders a new meme may appear but very often it fails since its fitness is usually smaller than meme fitness from its neighborhood.

For the authors of this article it is hardly conceivable that a similar detailed scenario of evolution of memes could be elaborated only on the basis of speculative considerations without an application of computational models of cognitive activities based on artificial neural networks and genetic algorithms. We believe that primarily in the field of creating detailed scenarios, mechanisms of the origin and evolution of different cognitive processes, important contributions by modern computer science for cognitive science can be achieved. This should also be a basis for a transformation of cognitive science into a modern interdisciplinary science situated on the border of humanities and science.

Acknowledgments

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Appendix: Numerical Calculations

A pseudo Pascal code of the simple GA simulation of evolution of memes over territory divided into compartments is outlined in Algorithm 1. Its parameters are

(1) Territory T is divided into compartments that are situated at vertices of an orthogonal grid $N \times N$ folded to toroid (see Fig. 1)
(2) N, size of orthogonal grid ($N = 10$)
(3) $time_{max}$, maximal number of epochs ($time_{max} = 300$)
(4) n, number of neurons in a layer ($n = 5$)
(5) f_{min} and f_{max}, minimal and maximal fitness ($f_{min} = 0.0$, $f_{max} = 1.0$)
(6) ξ, rate of fitness calculation ($\xi = 1.0$)
(7) P_{copy}, probability of application of copy process ($P_{copy} = 0.5$)
(8) P_{mut}, probability of 1-bit mutation in creation process ($P_{mut} = 0.05$)
(9) λ, learning rate ($\lambda = 1.0$)
(10) μ, momentum rate ($\mu = 0.7$)
(11) ε, opportunistic threshold for mutations ($\varepsilon = 0.2$)
(12) k_{max}, maximal number of adaptation steps ($k_{max} = 50$)
(13) δ, migration threshold ($\delta = 0.1$)
(14) Initial values of weight and threshold coefficients are randomly generated from interval [–1, 1], a readaptation process is started from the old coefficients

Illustrative numerical results obtained by Algorithm 1 with parameters specified above are presented in Figs. A1–A3. Plots in Fig. A1, diagram A, show that in the course of evolution one can observe monotonous increase of average and maximal fitness of memes. There exists a big gap between average and maximal fitness, this means that only a few memes are well adapted with respect to the optimal semantic structure z_{opt}, all other memes induce hidden activities (i.e. an internal representation of the meme) that are relatively different from the required semantic structure z_{opt}. The plots in diagram B show an increasing tendency of clustering of neighboring memes into different clusters where each cluster consists of identical memes with no identical memes outside cluster neighboring with inside memes. At the end of evolution all memes are divided into 8–10 clusters. A few of clusters cover almost all memes whereas the remaining clusters are composed of fewer memes and thus they are of a marginal importance from an evolutionary point of view. The plots in Fig. A2 show an evolution of probabilities w_i (17) (diagram A) and mean values of hidden activities (diagram B). We see that there is a general tendency to converge to an asymptotical state, where some components are already stable while other ones are still oscillating. Fig. A3, diagrams A, contain a decomposition of all memes into clusters that are composed of the same memes. Each oval corresponds to a cluster represented by the meme and by average and maximal

```
generate randomly optimal semantic structure z_opt;
for i := 1 to N × N do
begin generate randomly meme x_i;
    generate randomly weight and threshold coefficients of neural network NN_i;
    adapt neural network NN_i with respect to the meme x_i;
    evaluate meme x_i by fitness;
end;
calculate probability vector w;
time := 0;
while time < time_max do
begin time := time + 1;
    for i: = 1 to N × N do
    if random[0,1] < P_copy then C'_i := O_copy(C_i) else C'_i := O_mig(C_i);
    for i := 1 to N × N do C_i := C'_i;
    calculate probability vector w;
end;
```

Algorithm 1. Algorithm is initiated by a random generation of an optimal semantic structure z_{opt} and by a random generation of memes and weight and threshold coefficients of neural networks for all compartments. All neural networks are adapted by a prescribed number k_{max} with respect to compartment memes. After finishing the adaptation process of the current neural network the corresponding meme is evaluated by a fitness. The whole evolutionary epoch is repeated by prescribed number $time_{max}$. For each epoch we calculate new compartments such that with a probability P_{copy} we use the copy process, or in the opposite case we use the migration process. After formation of new compartments is finished, we update old compartment by new ones, and the process is repeated.

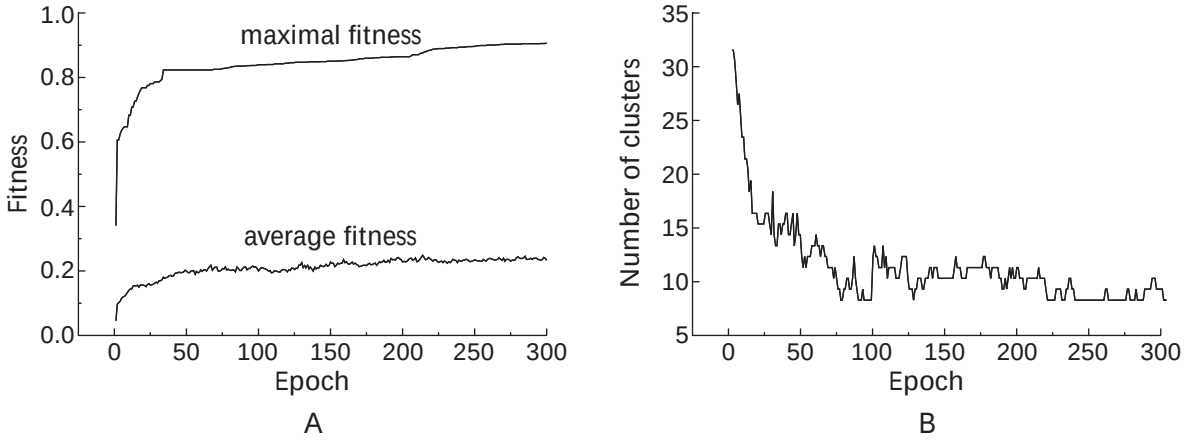

Figure A1. (A) Plots of average and maximal fitness. (B) Plot of number of clusters, where a cluster corresponds to a subset of all memes that are the same.

values of meme fitness. Two clusters are connected by an edge if their Hamming distance is equal to 1. (Hamming distance of two binary vectors equals to an amount of positions of one of vectors, where it has different binary values than the other vector.) Diagrams B specify a "geographical" distribution of the largest cluster assigned to the meme x = (10111), where the compartments occupied by this meme form a relatively compact areas on the territory. It should be stressed that the orthogonal grid of compartments is folded into a toriod, so that an array may unexpectedly continue on the opposite side of the grid.

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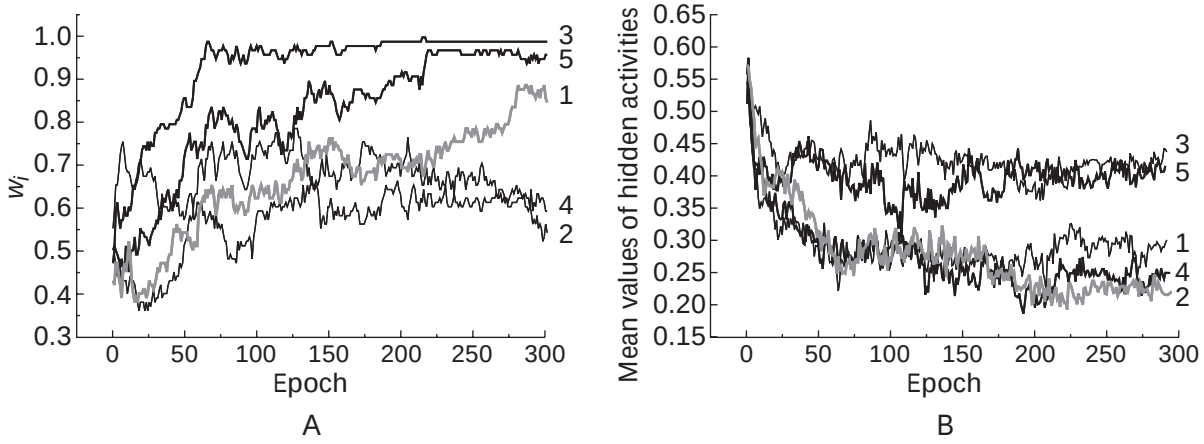

Figure A2. (A) Plots of probabilities w_i defined by (17). We see that entries 3 and 5 asymptotically tend to 1, this means that almost all memes from the territory T have both corresponding entries specified by $x_3 = 1$ and $x_5 = 1$. (B) Plots of mean values of hidden activities, where the optimal semantic representation is $z_{opt} = (00101)$. We see that lines denoted by 1, 2, and 4 asymptotically tend to zero whereas lines 3 and 5 kept fixed values near 0.5.

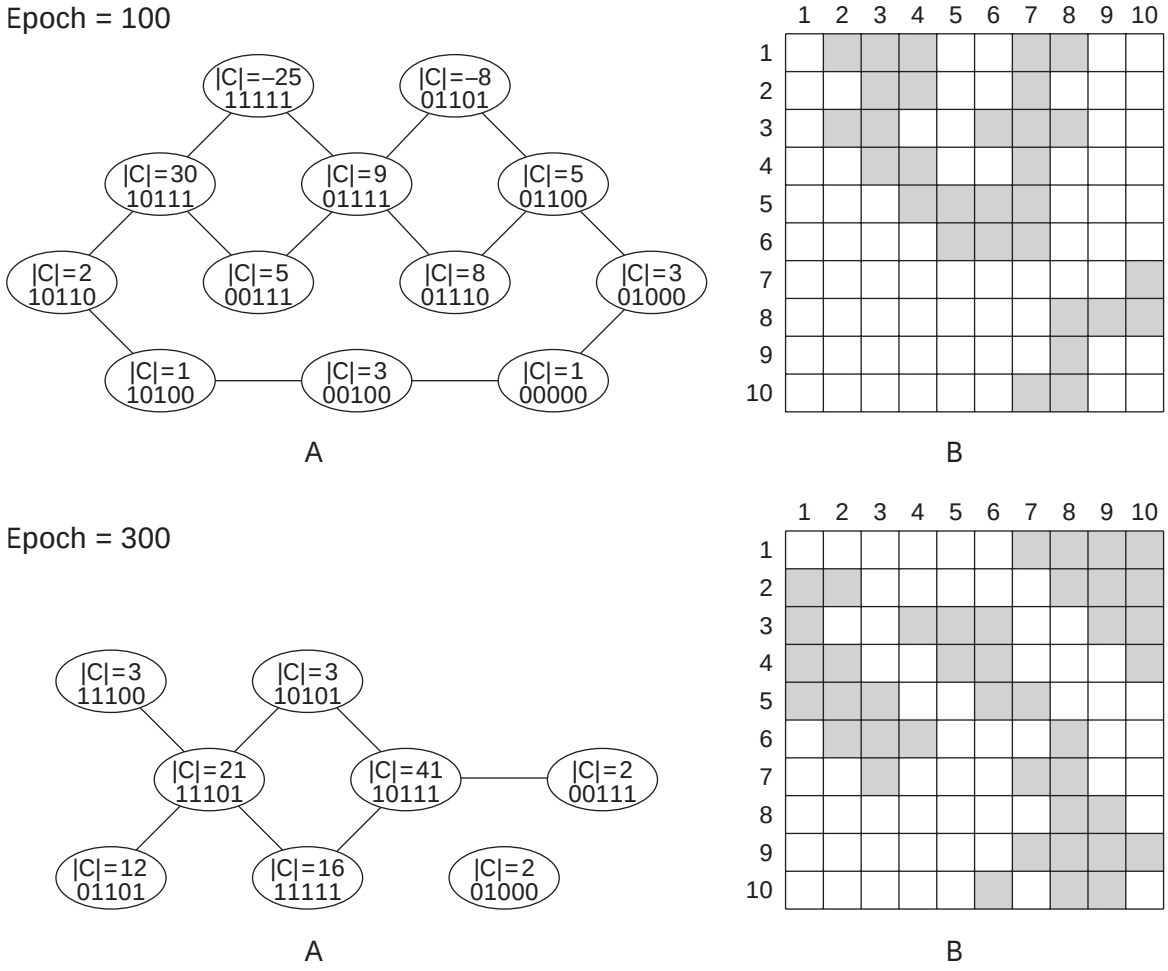

Figure A3. (A) Diagrammatic visualization of the biggest cluster on the territory T for two different epochs. Both these clusters correspond to a meme $x = (10111)$. Mean and maximal fitness for the meme x and for two different values of epochs are $f_{mean}^{(100)} = 0.236$, $f_{max}^{(100)} = 0.838$, and $f_{mean}^{(300)} = 0.242$, $f_{max}^{(300)} = 0.905$, respectively. (B) A topology of clusters for two different stages in evolution (determined by the numbers of epochs). Two clusters are connected by a solid line if the Hamming distance between the corresponding memes is equal to 1. Each cluster contains an information about the meme and the number of its copies in the cluster.

References

Bonner, J. T. (1980) The Evolution of Culture in Animals. Princeton University Press: Princeton, NJ.

Boyd, R./Richerson, P. J. (1985) Culture and the Evolutionary Process. The University of Chicago Press: Chicago.

Cavalli-Sforza, L. L./Feldman, M. W. (1981) Cultural Transmission and Evolution. A Quantitative Approach. Princeton University Press: Princeton, NJ.

Dawkins, R. (1976) The Selfish Gene. Oxford University Press: Oxford, UK.

Fogel, D. B. (1995) Evolutionary Computation. Toward a New Philosophy of Machine Intelligence. The IEEE Press: New York.

Gabora, L. M. (1995) Meme and Variations: A Computational Model of Cultural Evolution. In: Nadel, L./Stein, D. L. (eds) 1993 Lectures in Complex Systems, SFI Studies in the Science of Complexity. Addison-Wesley: Redwood City, CA, pp. 471–485.

Goldberg, D. E. (1989) Genetic Algorithms in Search, Optimization and Machine Learning. Addison-Wesley: Reading, MA.

Haykin, S. (1994) Neural Networks. A Comprehensive Foundation. MacMillan College Publishing: New York.

Hutchins, E./Hazlehurst, B. (1992) Learning and Cultural Process. In: Langton, C. G./ Taylor, C./Farmer, J. D./Rasmussen, S. (eds) Artificial Life II. Addison Wesley: Redwood City, CA, pp. 689–706.

Kvasnička, V./Pospíchal, J. (1999a) Simulation of Baldwin effect and Dawkins memes by genetic algorithm. In: Roy, R./Furuhashi, T./Chawdhry, P.K. (eds) Advances in Soft Computing—Engineering Design and Manufacturing. Springer-Verlag: London, pp.481–496.

Kvasnička, V./Pospíchal, J. (1999b) GA simulation of evolution of cognitive artifacts. Neural Network World 1–2: 25–42.

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Evolutionary Approaches to the Perception of Urban Spaces

Abstract

This paper points out that human perception of the environment was primarily formed during the evolution of Homo, and therefore our daily responses to urban habitats are also influenced by the needs of early humans. Habitat Theory was one of the first—followed by different others—to posit a connection between esthetic pleasure induced by an environment and the ability of that environment to meet biological needs. To recognise those features which characterise landscape units beneficial to survival, and to react with specific behaviours and feelings to them is likely to have evolved and to operate not only in the natural but also in today's built environment. Due to evolutionary factors, certain properties of the environment will tend to be preferred. Preferred environments, in turn, lead people to spend more time in them, leading to stronger social networks, with many positive consequences in terms of the safety and the quality of life in the community.

Empirical studies showing the influence of the structure and the content of the environmental features on human behaviour and human feelings of safety in urban environments are therefore important tools for city design.

Key words

Human behaviour, urban space, environmental aesthetics, habitat theory.

PROGRESSIVE GLOBAL urbanisation has confronted *Homo sapiens* with a habitat that—on the evolutionary scale—has changed very suddenly and differs dramatically from the environment in which hominisation took place. For the first time in history, more people live in urban than in rural settlements. By the year 2010, more than 500 urban centres will have at least one million inhabitants, and 26 of these will have a population of over 10 million (RABINOVITCH/LEITMAN 1996). Although the virtually limitless opportunities in modern urban centres provide residents with a unique measure of freedom of lifestyles, their very anonymity, structural shortcomings and lack of orientation—coupled with a reduced social coherence—are becoming an increasing problem (EIBL-EIBESFELDT 1995). This has led to the call for architects, biologists, landscape ecologists, psychologists, sociologists, regional planers and other experts to help formulate transdisciplinary urban planning concepts in order to mitigate existing problems and to avert the future deterioration. Human ethology can contribute here by applying fundamental biological concepts and theories to the behaviour of city dwellers and then determining whether, where and why deficits can be expected.

Habitat selection, i.e. the ability of individuals to seek and recognise an appropiate species-specific environment based on special factors, is a wide-ranging behaviour throughout the animal kingdom. The literature contains a considerable number of theoretical and empirical studies from which hypotheses on human behaviour can be derived as well. Since the selection of a preferred habitat decisively influenced the survival and reproductive success of the respective organism, the relevant behavioural mechanisms were subject to strong selection pressure over hundreds of thousands of years. Accordingly, the function and adaptation of a particular character or structural aspect of human activity cannot be understood based on its current role, but rather on its former function during the Pleistocene, the epoch in which modern man evolved (LORENZ 1973; COSMIDES/TOOBY 1987; SYMONS 1989, 1990). Emotional responses to the species-specific features of the environment should also be expected. This is based on the consideration that emotional reactions as motivators for human behaviour would not have developed if the behaviour that elicits them had not, on the average, had a positive effect on survival and reproductive success. Thus, our emotional responses to various spatial structures

and content categories are also the product of evolutionary history.

ORIANS (1980) developed the "savanna theory" of biotope preference in which he postulates that we show an innate preference for savanna biotopes. He bases this assumption on the fact that such a phylogenetic biotope imprinting must have taken place because selection favours those individuals who explored their surroundings and settled in habitats that provided the crucial resources for survival; at the same time, they avoided habitats that failed to provide these advantages. Landscape choice studies have confirmed a clear preference for savanna-like habitats (ORIANS 1980; BALLING/FALK 1982; ULRICH 1983, 1986). ORIANS lists the following variables that exert a positive influence on landscape selection and that can be interpreted to stem from phylogenetic adaptations to savannas: water, large trees, focal points, semi-open spaces, changes in elevations, unobstructed view of the horizon, plant growth and moderate complexity.

In 1975, APPLETON attempted an even more general approach to environmental aesthetics by formulating his first theory, the "habitat theory". It states that we preferred landscapes that promised to satisfy our basic biological needs, i.e., that signalised vital resources and invited further exploration.

EIBL-EIBESFELDT (1984) described this condition by referring to humans as being "phyto-" and "aquaphilic". The idea that structures that provide an easy to survey subtantial vegetation were useful features to evaluate the varying quality of savannas is based largely on an assumed need for security.

KUO et al. (1998) show in their study of inner city landscapes the strong effect of EIBL-EIBESFELDT's "phytophilia" concept.

A further elaboration of this concept led to the "prospect refuge theory" (APPLETON 1975, 1984), which assumes that natural selection favoured the survival of those individuals that preferentially settled in areas that provided prospect and refuge. In APPLETON's terminology, prospect means "having an overall grand view of the landscape" and refuge means "having a place to hide". The presence of structures that allow such a view would increase the likelihood of spotting resources such as water and food, of recognising approaching threats such as predators or enemies, and finally, of being able to foresee impending changes in the weather early enough. Choosing habitats with an ample view may have considerably helped early humans to make better decisions about the opportune time to move on, the area to settle next, and set priorities for their activities. At the same time, the presence of structures that provide refuge, especially in precarious situations, should be crucial. While the factor prospect enables danger to be perceived early on in a landscape, refuge points to the availability of shelter and hiding places. Since the advantages of seeking a landscape with such prospect and refuge opportunities appear to be great, the assumption is that our ancestors developed positive response patterns to areas that exhibited both qualities.

Stephen and Rachel KAPLAN (1982, 1987, 1992) point out that successfully negotiating terrain required skill and knowledge of the environment, both then and now. Accordingly, those landscapes that signal the observer an opportunity to explore without losing orientation are preferred over those that fail to satisfy or even hinder this need. KAPLAN's preference matrix contains four predictors that describe these exploration and orientation possibilities. In a spontaneous decision, visual complexity helps determine the exploration quality, while coherence aids in rapid understanding. If more time is available for decision-making, then legibility helps in understanding, and the mystery of the landscape helps to properly evaluate the exploration possibilities. Although high complexity and mystery are direct indicators of ecological diversity and therefore wake our interest, the assumption is that those factors that help our understanding must have a greater influence on preference because they enable orientation, which is vital in real-life situations.

Regardless of the sequence, weighting or interrelationships one may attach to these processes, one thing is clear: reactions to different structures and contents in our environment have developed and these are related to our basic biological needs.

These perceptual qualities play a role not only in our natural environment, but are also effective in the urban context. As indicated in the above discussion, the literature distinguishes two realms of aesthetic variables: on the one hand the investigation of the structure of features, the so-called formal aesthetics, and on the other hand the analysis of the contents of the features, the symbolic aesthetics[1] (LANG 1988). Whereas the distinguishing characteristics of formal aesthetics are form, proportion, rhythm, complexity, spatial arrangement, incongruence, novelty, etc., the features of symbolic aesthetics include style, material, resources, degree of naturalness, water, trees, etc. (GROAT/DESPRES 1990; LANG 1988).

Research on symbolic aesthetics has confirmed the key role of natural versus artificial content on

preferences in the urban environment. Studies have revealed that artificial contents (such as masts, cables and lines, signs, vehicles and intensive use such as by industry) can lower the preference (ANDERSON et al. 1983; APPLEYARD 1981; HERZOG et al. 1976; NASAR 1990, 1994) and have confirmed an overall preference for the natural over the artificial (KAPLAN/KAPLAN 1989; NASAR 1983, 1984). In urban areas, TAYLOR/ATWOOD (1978) reported that the addition of natural material increases the preference, and ULRICH (1984; ULRICH et al. 1991) has demonstrated the relaxing and refreshing effect of nature. KUO et al. (1998) showed the effect of trees and grass maintenance for preference and sense of safety, and TAYLOR et al. (1998) showed the positive effect trees and grass have on the frequencies of childrens' play and on their access to adults.

On the other hand, formal variables have also proved to be crucial for a positive evaluation. HERZOG (1989, 1992), for example, who examined preferences for urban spaces as a function of spatial categories and KAPLAN's preference variables, was able to demonstrate that order and complexity appeared to be consistent predictors for a preference. Most studies confirm a positive correlation between complexity and interest (NASAR 1983, 1987; OOSTENDORP/BERLYNE 1978; WOHLWILL 1976). The relationships between preference and complexity are less consistent. Some studies were able to attribute preference to the complexity of certain substantive categories (HERZOG et al. 1976; 1992; KAPLAN/KAPLAN 1989; WHITFIELD 1983). Linearly positive correlations between complexity and preference have repeatedly been reported, among others by DEVLIN/NASAR (1989), HERZOG et al. (1976) and ORLAND et al. (1995).

Based on the assumption that evolution favoured those individuals who reacted to specific environmental structures with positive or negative emotions, which in turn triggered a spectrum of behaviours ranging from settlement to rejection, different behaviours have also been postulated for outdoor spaces of different quality in the urban environment (SCHÄFER 1997; ATZWANGER et al. 1998). Their work was deeply stimulated by JACOBS (1961) and NEWMAN (1972), who postulated with the "defensible space" concept, that individuals would under certain circumstances take over responsibility for their close environment. The key factor in JACOBS' (1961) and NEWMAN's (1972) argumentation is the clear determination of semi public areas from public areas with building structures to enhance social control and identification with the individuals own habitat. According to NEWMAN (1972) social control and identification with semi public areas should therefore decrease criminality. But what is the behavioral reaction of well being and identification, and what are the consequences for social networks?

The most appropriate measure of well-being in humans, in the sense of a response to the outdoor structure, is primarily the duration of stay (ATZWANGER et al. 1997), while rejection would be indicated by rapid departure; places that invite exploration would be indicated by longer stays. GOFFMAN's (1971) observation that the environment is constantly being scanned for cues that might signal danger and that the site is immediately abandoned if threats materialise, supports this assumption (WARR 1990). If positive emotions are triggered, then outdoor spaces should also be actively sought out. Longer and more frequent stays have two social effects: interactions occur on one hand through repeated chance encounters in outdoor settings, on the other hand through jointly seeking out such settings. Both possibilities in turn increase the duration of stay and, therefore the likelihood of encountering one another. Accordingly, well-being should set a process in motion which increases the probability of future re-encounters through more frequent and lengthier stays by users; this would promote the basis for cooperation among users (SCHIEFENHÖVEL/GRAMMER 1988). These arguments refer to the classical game theoretical model that individuals recognition and a higher probability of future encounters can lead to cooperation (AXELROD 1984).

At least in housing developments, the duration of stay and interaction frequencies are indicator of and impulse for satisfaction with living conditions (SCHÄFER 1994; SCHÄFER/GRAMMER 1996). In consequence, the social net of users or residents should become tighter, which should be reflected in the closer degree of acquaintanceship at the place or between residents. In large housing developments, it is well established that anonymity is associated not only with crime but also with vandalism (EIBL-EIBESFELDT et al. 1985; EIBL-EIBESFELDT 1995; ALTMAN/Rogoff 1987; FLADE 1987; NOHL/RICHTER 1988; NASAR/FISHER 1993; HARLOFF et al. 1993). Consequently, one can expect less wilfully destroyed objects and garbage at those outdoor sites that permit cooperation between users than at sites that promote anonymity.

Another interesting aspect is the effect of structure on the behaviour of the user. In the words of EIBL-EIBESFELDT (1995),"Places can only bring people

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together when people actually spend time there"; the author also wrote "Comfort means security, and in a relaxed, friendly atmosphere humans are more inclined to seek contact with others. The aesthetic design of places becomes a crucial aspect". The data of TAYLOR et al. (1998), which reports of children's play under low and high vegetation conditions show, that children not only play more in high vegetation settings but their play is much more creative in such settings. The importance of vegetation for places where children can grow up in a socializing atmosphere can therefore be seen as very important.

In their investigations of central squares of housing developments, SCHÄFER and GRAMMER (1996) were able to confirm a positive correlation between the number and duration of recorded contacts, the degree of familiarity with one another in the complex, and overall satisfaction with living conditions. Accordingly, in such a setting one expects fewer attacks involving inhabitants of the same complex, with better recognition of outsiders and mutual assistance. Assuming that a topographically and temporally divided interaction space is a measure for group identification, then the intensity of communication also demonstrates the extent of such social cohesiveness. In housing developments, it became evident that the residents of complexes with low interaction rates identified themselves less with the communal territory than those with higher interaction rates (SCHÄFER 1994). The interaction rates measured at the central square therefore reflect the group's identification with its territory and its satisfaction with the surrounding living space (SCHIEFENHÖVEL/GRAMMER 1988).

The available research on the interplay between emotional reactions and behavioural responses to environmental structures, with game theory models on the development of cooperation, should be understood as building blocks in the interdisciplinary effort to improve the quality of life in urban settings.

Based on such investigations, urban ethology—as an applied branch of research of human ethology—can help in designing public spaces.

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Note

1 From an evolutionary position the term symbolic aesthetics could be criticized as misleading, because we expect people to prefer, e.g., trees and water for what they are and not because serving as a symbol. Therefore from our standpoint the term "content aesthetics" would be more appropriate for symbolic aesthetics.

References:

Altman, I./Rogoff, B. (1987) World views in psychology: trait, interactional, organismic, and transactional perspectives. In: Stokols, D./Altman, I. (eds) Handbook of Environmental Psychology. New York, Chichester, Brisbane, Toronto, Singapore: John Wiley & Sons, pp. 7–40.

Anderson, L. M./Mulligan, B. E./Goodman, L. S./Regen, H. Z. (1983) Effects of sounds on preference for outdoor settings. Environment and Behavior 15: 539–566.

Appleton, J. (1975) The Experience of Landscape. London: Wiley & Sons.

Appleton, J. (1984) Prospect and refuge re-visited. Landscape Journal 3: 91–103.

Appleyard, D. (1981) Livable streets. Berkely: University of California Press.

Atzwanger, K./Schäfer, K./Sütterlin, C./Kruck, K. (1997) Habitat quality and cooperation in humans. In: Taborski, M./Taborski, B. (eds) Advances in Ethology 32. Supplement 32 to "Ethology" formerly Zeitschrift für Tierpsychologie.

Atzwanger, K./Schäfer, K./Kruck, K./Sütterlin, C. (1998) Wohlbefinden und Kooperation im öffentlichen Raum: Eine humanethologische Feldstudie. Report Psychologie 5: 450–455.

Axelrod, R. (1984) The Evolution of Cooperation. New York: Basic Books.

Balling, J. D./Falk, J. H. (1982) Development of visual preference for natural environments. Environment and Behavior 14(1): 5–28.

Cosmides, L./Tooby, J. (1987) From evolution to behavior: evolutionary Psychology as the missing link. In: Dupré, J.

(ed) The Latest on the Best—Essays on Evolution and Optimality. MA & London: MIT Press Cambridge, pp.277–306.

Devlin, K./Nasar, J. L. (1989) The beauty and the beast: Some preliminary comparisons of "high" versus "popular"residential architecture and public versus architect judgement of the same. J. Environm Psych. 1: 33–42

Eibl-Eibesfeldt, I. (1984, 1995) Die Biologie des menschlichen Verhaltens—Grundriß der Humanethologie, 3rd ed. München: Piper.

Eibl-Eibesfeldt, I./Hass, H./Freisitzer, K./Gehmacher, E./Glück, H. (eds) (1985) Stadt und Lebensqualität. Wien: DVA.

Flade, A. (1987) Wohnen Psychologisch Betrachtet. Stuttgart, Toronto, Bern: Huber.

Goffman, E. (1971) Relations in Public: Micro Studies of the Public Order. New York: Harper & Row.

Groat, L./Despres, C. (1990) The significance of architectural theory for environmental design research. In: Zube, E. H./Moore, G. T. (eds) Advances in Environment, Behavior, and Design (4). New York: Plenum Press, pp. 3–53.

Harloff, H. J./Hinding, B./Schmoll, R./Weckwerth, H. (1993) Bedeutung von Übergangszonen und Zwischenbereichen für Wohnerleben und Wohnhandeln. In: Harloff, H. J. (ed) Psychologie des Wohnungs- und Siedlungsbaus. Göttingen, Stuttgart: Verlag für Angewandte Psychologie, pp. 149–173.

Herzog, T. R. (1989) A cognitive analysis of preference for urban nature. Journal of Environmental Psychology 9: 27–43.

Herzog, T. R. (1992) A cognitive analysis of preference for urban spaces. Journal of Environmental Psychology 12: 237–248.

Herzog, T. R./Kaplan, S./Kaplan, R. (1976) The prediction of preference for familiar urban places. Environment and Behavior 8: 627–625.

Jacobs, J. (1961) The Death and Life of Great American Cities. New York: Vintage.

Kaplan, R./Kaplan, S. (1989) The experience of Nature: A Psychological Perspective. New York: Cambridge University Press.

Kaplan, S. (1987) Aesthetics, affect, and cognition: environmental preference from an evolutionary perspective. Environment and Behavior, 19 (1), 3–32.

Kaplan, S. (1992) Environmental Preference in a Knowledge-Seeking, Knowledge-Using Organism. In: Barkow, J. H./Cosmides, L./Tooby, J. (eds) The Adapted Mind: Evolutionary Psychology and the Generation of Culture. New York: Oxford University Press, pp. 581-598.

Kaplan, S./Kaplan, R. (1982) Cognition and Environment: Functioning in an uncertain world. New York: Praeger.

Kuo, F. E./Bacaicoa, M./Sullivan, W. C. (1998) Transforming inner city landscapes. Trees, sense of savety, and preference. Environment and Behavior 30: 28–59.

Lang, J. (1988) Symbolic aesthetics in architecture: toward a research agenda. In: Nasar, J. L. (ed) Environmental Aesthetics: Theory, research and applications. New York: Cambridge University Press, pp. 11–26.

Lorenz, K. (1973) Die Rückseite des Spiegels. Versuch einer Naturgeschichte menschlichen Erkennens. München: Piper.

Nasar, J. L. (1983) Adult viewers' preferences in residential scenes: a study of the relationship of environmental attributes to preference. Environment and Behavior 15: 589–614.

Nasar, J. (1984) Visual preference in urban street scenes: cross-cultural comparison between Japan and the United States. Journal of Cross-Cultural Psychology 15: 79–93.

Nasar, J. (1987) Effects of signscape complexity and coherence in the perceived visual quality of retail scenes. Journal of the American Planning Association 53: 499–509.

Nasar, J. L. (1990) The evaluative image of the city. Journal of the American Planning Association 56: 41–53.

Nasar, J. L. (1994) Urban design aesthetics: the evaluative qualities of building exteriors. Environment and Behavior (3)26: 377–401.

Nasar, J. L./Fisher, B. (1993) Hot spots of fear and crime: A multi-method investigation. Journal of Environmental Psychology 13: 187–206.

Newman, O. (1972) Defensible Space—Crime Prevention through Urban Design. New York: McMillam.

Nohl, W./Richter, U. (1988) Umweltverträgliche Freizeit, freizeitverträgliche Umwelt—Ansätze für eine umweltorientierte Freizeitpolitik im Rahmen der Stadtentwicklungspolitik. Dortmund: ILS Schriften.

Oostendorp, A./Berlyne, D. E. (1978) Dimensions in the perception of architecture: Identification and interpretation of of dimensions of similarity. Scandinavian Journal of Psychology 19: 73–82.

Orians, G. H. (1980) Habitat selection: general theory and applications to human behavior. In: Lockard, J. S. (ed), The Evolution of Human Social Behavior. New York: Elsevier, pp. 49–66.

Orland, B./Weidemann, E./Larsen, L./Radja, P. (1995) Exploring the relationship between visual complexity and perceived beauty. Imaging Systems Laboratory. Department of Landscape Architecture, Univ. of Illinois. Internet page: http://www.imlab.uiuc.edu/complex/index.html

Rabinovitch, J./Leitman, J. (1996) Stadtplanung in Curitiba. Spektrum der Wissenschaft 5: 68–75.

Schäfer, K. (1994) Kommunikation und Zufriedenheit in Wohnanlagen. Diplomarbeit, Universität Wien.

Schäfer, K. (1997) Das sozialintegrative Potential von Stadtplätzen—eine humanethologische Feldstudie. Dissertation, Universität Wien.

Schäfer K./Grammer, K. (1996) Wohlbefinden in Wohnanlagen—eine humanethologische Feldstudie. In: Röller, D. (ed) Stadt und Mensch: Zwischen Ordung und Chaos. Frankfurt am Main: Peter Lang, Europäischer Verlag der Wissenschaften.

Schiefenhövel, W./Grammer, K. (1988) Sozialverhalten als Maß für Wohlbefinden und Wohnzufriedenheit. In: Interdisziplinäre Methoden und Vergleichsgrundlagen zur Erfassung der Wohnzufriedenheit. Wien: Institut für Stadtforschung.

Symons, D. (1989) A critique of Darwinian anthropology. Ethology and Sociobiology 10: 131–144.

Symons, D. (1990) Adaptiveness and adaption. Ethology and Sociobiology 11: 427–444.

Taylor, R. L./Atwood, B. G. (1978) Plant complexity, and pleasure in urban and suburban environments. Environmental Psychology and Nonverbal Behavior 3: 67–76.

Taylor, A. F./Wiley, A./Kuo, F. E./Sullivan, W. C. (1998) Growing up in the inner city. Green spaces as places to grow. Environment and Behavior 30: 3–27.

Ulrich, R. S (1983) Aesthetic and affective response to natural environment. In: Altman, I./Wohlwill, J. F. (eds) Human Behaviour and the Environment: Advances in Theory and Research. New York: Plenum Press, pp. 85–125.

Ulrich, R. S. (1984) View through a window may influence recovery from surgery. Science 224: 420–421.

Ulrich, R. S. (1986) Human response to vegetation and landscapes. Landscape and Urban Planning 13: 29–44.

Ulrich, R. S./Simons, R. F./Losito, B. D./Fiotito, E./Miles, M. A./Zelson, M. (1991) Stress recovering during exposure to natural and urban environments. Journal of Environmental Psychology 11: 201–230.

Warr, M. (1990) Dangerous situations: social context and fear of victimization. Social Forces 68: 891–907.

Whitfield, T. W. A. (1983) Predicting preference for everyday objects: an experimental confrontation between two theories of aesthetic behavior. Journal of Environmental Psychology 3: 221–237.

Wohlwill, J. F. (1976) Environmental aesthetics: the environment as a source of affect. In: Altman, I./Wohlwill, J. F. (eds) Human Behaviour and the Environment: Advances in Theory and Research. New York: Plenum Press, pp. 37–86.

Zusammenfassungen der Artikel in deutscher Sprache

James Barham

Über den ontologischen Status der „scala naturae“

Daß die Welt der Organismen eine hierarchische Struktur besitzt – traditionellerweise als „scala naturae“ bezeichnet erschien den meisten Vertretern der westlichen Denktradition selbstverständlich. Auch moderne wissenschaftliche Ergebnisse unterstützen diese Annahme. Kritische Argumente gegen diese Position gehen davon aus, daß der wahrgenommenen hierarchischen Struktur keinerlei objektiver Gehalt zukommt, sonder es sich dabei um ein Artefakt handelt.

Eine mehr quantifizierende Zugehensweise zu diesem Problem ermöglicht der Komplexitätsbegriff, welcher die Voreingenommenheiten der menschlichen Perspektive zu umgehen trachtet. Komplexität steht in engem Zusammenhang mit dem Informationsbegriff, welcher hinsichtlich seines Objektivitätsgehaltes und seines Bedeutungsgehaltes untersucht wird.

Ausgehend von der semantischen Ebene von Information wird ein Modell biologischer Funktionalität erarbeitet, welches als Basis für ein objektives Maß biologischer Komplexität dienen kann. In einem letzten Abschnitt wird deutlich gemacht, daß das Konzept der „epistemic depth“ mit unserem intuitiven Sinn für biologische Komplexitäten übereinstimmt, was die Objektivitätsthese der scala naturae unterstützt.

Alfred K. Treml

Allgemeinheit und Notwendigkeit. Kants Ethik im Lichte der modernen Evolutionsforschung

Die Evolutionäre Erkenntnistheorie hat die „Aprioris“ der KANT’schen Erkenntnistheorie evolutionstheoretisch – und damit aposteriorisch – reformuliert. Analog dazu kann man auch die „Aprioris“ der KANT’schen Ethik evolutionstheoretisch – und damit aposteriorisch – interpretieren. KANTs Ethik mit ihren beiden Pfeilern der „Allgemeinheit“ und der „Notwendigkeit“ kompensiert spezifische Adaptionsmängel an eine soziale Evolution, die zu immer größeren und anonymeren sozialen Systemen mutierte. Mit dem Prinzip der Allgemeinheit offeriert sie einen nützlichen sekundären (d.h. kulturellen) Selektionswert für ein kooperatives Verhalten in einem intransparenten sozialem System. Die Aufforderung des Kategorischen Imperativs „universalisiere!“ heißt aus evolutionstheoretischer Sicht einfach: Überschreite Deine genetische Fixierung auf den sozialen Nahbereich! Und mit dem Prinzip der Notwendigkeit bedient die KANT’schen Moraltheorie den hohen Bedarf an Sicherheit bei der Kontingenzregulierung menschlicher Handlungsmotive nach dem Zurücktreten der Angeborenen Auslösenden Mechanismen beim Menschen.

Thomas Mohrs

Kants Geschichtsphilosophie aus evolutionstheoretischer Sicht

Der Versuch einer „Verbindung“ der Philosophie Immanuel KANTs mit einem evolutionstheoretischen bzw. soziobiologischen Ansatz erscheint auf den ersten Blick als absurd. Der Artikel zeigt jedoch, daß es nicht nur möglich ist, die Geschichtsphilosophie KANTs aus evolutionstheoretischer Perspektive kritisch zu reformulieren, sondern daß diese „Zusammenschau“ auch eine solide Basis für ein fruchtbares Weiterdenken im Hinblick auf *heutige* gesellschaftliche und politische Probleme und Fragestellungen ergeben kann.

Nach einer knappe Darstellung der Geschichtsphilosophie KANTs sowie dazu korrespondierenden evolutionstheoretischen Thesen wird die Frage der prinzipiellen Kompatibilität erörtert und anschließend daran ein wesentlicher Unterschied zwischen beiden Theorieansätzen eingehender diskutiert. Diese Diskussion mündet abschließend in einem Plädoyer für KANTs „pragmatischen Optimismus“.

Wolfgang Lipp

Die Familie: Biologische Grundlagen, frühe kulturelle Entwicklungen. Plädoyer für eine integrierte evolutionstheoretische Betrachtungsweise

Gegenstand dieses Beitrags ist die (menschliche) Familie. Sie ist Produkt, zugleich aber auch Träger eines Evolutionsprozesses (und von Evolution generell), der neben „materiellen“ auch „geistige“ Dimensionen aufweist und von physiko–organischen (organismischen) Stufen des Kosmos durchläuft (aufsteigt) zu sozialen und kulturellen Ebenen der Organisation (Strukturierung) des Seins. Im einzelnen werden a) methodisch–methodologische, b) inhaltliche Fragen verfolgt. Methodisch–methodologisch geht es darum, Kriterien und Gründe zu benennen, die es ratsam und machbar erscheinen lassen, einen neuen, Natur und Kultur zugleich umfassenden, integrierten Begriff von Evolution zu schaffen. Ein wichtiger Gesichtspunkt dazu ist, Evolution nicht nur als „graduellen“, sondern als „saltuellen“ („sprunghaften“) Prozeß zu verstehen. Gegenüber älteren wissenschaftlichen Positionen wird hierzu angeführt, daß Gradualität und Saltualität sich nicht ausschließen müsse; die genannten Schrittweisen sind evolutionär vielmehr in sich verklammert; sie durchdringen sich, wie konzeptionell vorgeschlagen wird, in der Figur des „Wechselschritts“.

Stellen Wechselschritte Zwischenglieder dar, die zwischen Natur und Kultur methodisch–methodologisch vermitteln, erscheint als „missing link“, das die Sphären inhaltlich verbindet, die Familie. Die Familie überspannt den fraglichen (biosozialen, biokulturellen) Übergangsbereich dabei nicht indifferent, sondern prägt ihn neu und muß als „Ursprung“, „Basislager“, Erstform („Urinstitution“) von Kultur überhaupt verstanden werden. Die Familie wandelt, so gesehen, an evolutionär entscheidender Stelle „reproduktive“, „fortpflanzungsdienliche“ biologische Vorgänge in „prokreative“, „kulturschöpferische“ Setzungen um. Dabei unterliegt sie entscheidenden transformativen Prozessen auch selbst. Der Zusammenhang wird am Beispiel der Überführung von „sex“ in „gender“, der „Erfindung des Vaters“, der Entstehung von „Verwandtschaft“ bis hin zur aufbrechenden kulturevolutionären Gabelung, an der „Männerbünde“ entstanden, interdisziplinär erörtert.

Achim Stephan

Formen der Emergenz

Verschieden starke Varianten des Emergentismus werden erörtert und am Beispiel konnektionistischer Netze und der Qualia–Debatte erprobt. Der auch mit reduktionistischen Positionen verträgliche *schwache* Emergentismus läßt sich durch die folgenden Annahmen charakterisieren: (i) die These des *physischen Monismus*, wonach alle Entitäten dieser Welt nur aus *physischen* Bestandteilen bestehen, (ii) die Annahme, daß es *systemische Eigenschaften* gibt, also Eigenschaften, die zwar ein System als Ganzes, aber keiner seiner Bestandteile besitzt, und (iii) die These der *synchronen Determiniertheit*, derzufolge die systemischen Eigenschaften von den Eigenschaften der Systemkomponenten und deren Anordnung abhängen.

Schwache Emergenztheorien können auf unterschiedliche Weise verstärkt werden. Für den (starken) *synchronen* Emergentismus ist (iv) die These der *Irreduzibilität* systemischer Eigenschaften wesentlich. Sie besagt, daß die systemischen Eigenschaften nicht *reduktiv* aus der Anordnung der Systembestandteile sowie den Eigenschaften, die jene ‘isoliert’ oder in einfacheren Systemen haben, *erklärt* werden können. Der synchrone Emergentismus ist nicht mehr mit dem reduktiven Physikalismus verträglich. Er spielt in der Qualia–Debatte und bei der Unterscheidung verschieden starker nicht-reduktiv physikalistischer Positionen eine wichtige Rolle. *Diachrone* Emergenztheorien ergänzen die schwache Emergenztheorie um den zeitlichen Aspekt der Unvorhersagbarkeit genuin neuartiger Eigenschaften: (v) die *Neuartigkeitsthese* ist für diese Theorien ein unverzichtbarer Bestandteil; sie unterstreicht den evolutionären Aspekt in der vermeintlich ‘emergenten’ Evolution und schließt zugleich alle präformationistischen Positionen aus; aber erst (vi) die These der prinzipiellen *Unvorhersagbarkeit* führt zu stärkeren *diachronen* Emergenztheorien.

Walter Hauptmann

Recht als Produkt der kulturellen Information

Die Grundprinzipien der *biologischen* Evolution sind seit langem bekannt. Durch sexuelle Rekombination und durch spontane Mutationen des Erbguts von Lebewesen entstehen bei ihren Nachkommen

Merkmalsveränderungen, deren Träger der jeweiligen Umwelt besser oder auch weniger gut angepaßt sind als ihre genetischen Vorgänger. Die Natur lernt also sozusagen aus Versuch und Irrtum. Der Umgebung besser Angepaßte verdrängen früher oder später schlechter Adaptierte. Die biologische Evolution ist also ein endloser Anpassungs- und Ausleseprozeß mit prinzipiell offenem Ausgang.

Nicht grundsätzlich anders verläuft der Prozeß der kulturellen Evolution, von dem wir immer dann sprechen, wenn eine Population irgendeine neue Verhaltensweise entwickelt, wobei diese aber nicht über Vererbung, also biogenetisch, sondern durch Vermittlung von Information (über Sprache, Schrift, Bild, etc.), demnach tradigenetisch, an die nächste Generation weitergegeben wird. Natürlich können sich auch tradigenetisch vermittelte Eigenschaften in der nächsten Generation jeweils als Vorteil oder als Nachteil im Daseinskampf herausstellen. Was speziell den Menschen betrifft, besteht der Unterschied zwischen biogenetischer und tradigenetischer Entwicklung vor allem darin, daß nur die tradigenetische Informationsvermittlung in der Lage ist, innerhalb sehr kurzer Zeit vergleichsweise größte Datenmengen zu übertragen. D.h. Anpassung durch kulturelles Lernen geschieht unvergleichlich schneller als durch genetisches Lernen.

Abgesehen von diesem Unterschied in der Lerngeschwindigkeit gibt es aber doch eine Vielzahl von Analogien zwischen beiden erwähnten Evolutionstypen. Daher kann man zumindest versuchen, auch Rechtsordnungen als Produkt eines kulturellen Evolutionsprozesses zu deuten. Ein solches Gedankenexperiment zeigt nicht nur Ähnlichkeiten beider Evolutionstypen auf. Es kann auch gewisse Systemeigenschaften des Rechts besser verständlich und begreiflich machen.

Vladimír Kvasnička und Jiří Pospíchal

Dawkins Meme: Simulation und Evolution

Ausgangspunkt der Überlegungen ist DAWKINS Begriff der „Meme“. In Anlehnung an den Genbegriff spricht DAWKINS den Memen ebenso die Tendenz zur Ausbreitung im „Meme pool“ zu. In der vorliegenden Arbeit werden die Ergebnisse einer Computersimulation der Evolution von Memen dargestellt. Dabei wird die Memevolution im Zusammenhang mit einer Gruppe neuronaler Netze simuliert. Dabei ist die „Landschaft“ in der sich diese Evolutionsprozesse vollziehen in einzelne Kompartimente unterteilt, die alle von einem Mem und einem neuronalen Netz besetzt sind. Dabei wurde zwei unterschiedliche Memveränderungen studiert: Kopie von Memen und Wanderung von Memen, die dazu führen, daß Meme in benachbarte Kompartimente einwandern.

Der Verlauf der Simulation macht deutlich, daß in der ersten Phase der Evolution zahlreiche unterschiedliche Memtypen auftauchen, jedoch nach einer Übergangsphase die Anzahl unterschiedlicher Meme beträchtlich abnimmt und die verbleibenden räumlich getrennt vorliegen.

Klaus Atzwanger und Katrin Schäfer

Evolutionäre Aspekte der Wahrnehmung urbaner Räume

Davon ausgehend, daß sich Funktion und Angepaßtheit eines bestimmten Merkmals oder eines Verhaltens nicht entwickelt hätte, wenn es sich nicht durchschnittlich positiv auf das Überleben und den reproduktiven Erfolg des Individuums ausgewirkt hätte, muß auch einem Merkmal wie der artspezifischen Reaktion auf die Umgebung eine solche Erklärung zugrunde liegen. Wenn Umwelten Strukturen aufweisen, die während der Hominisation ein Signal für hohe Habitatqualität dargestellt haben, müßten diese auch heute noch positive Reaktionen im Menschen hervorrufen.

In dieser Arbeit wird ein Überblick über die vorliegenden Ergebnisse evolutionärer Überlegungen zur Landschaftswahrnehmung gegeben, sowie die Übertragbarkeit und Auswirkung solcher Studien auf urbane Lebensräume diskutiert. Aufgrund von Theorien zur Entstehung von Kooperation wird über die positive Beeinflussung der Interaktionen und des Bekanntschaftsgrades von Menschen auch eine Steigerung der Qualität von sozialen Netzen erwartet.

Das Zusammenspiel von emotionalen Reaktionen und Verhaltensantworten auf Umweltstrukturen aufgrund evolutionärer Anpassung mit Modellen zur Entstehung von Kooperation kann als Baustein im transdisziplinären Bemühen um städtische Lebensqualität gesehen werden.