In: Sandkuehler, H.J. and Nannini, S. (eds.)
Naturalism in the Cognitive Sciences and in the Philosophy of Mind
Bern, Peter Lang Verlag, 2000, 75-87

# The naturalization of humans

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"Looking at things from a distance reduces history to nature"
Winstan Hugh Auden

## 1. Naturalization

Humans need to be naturalized because our conception and understanding of them sofar has not been "natural". Humans have been viewed as "special", not in the perfectly ordinary sense in which any aspect, entity, phenomenon of nature is special and unique, that is, possessing (some) properties not shared by any other entity or phenomenon, but "special" in a special sense. Humans have been contrasted with all the rest of nature, in a sense as being located outside nature and contemplating nature from outside. In very general terms, the naturalization of humans means to cease to view humans as special in this special sense and to reintroduce humans into nature, to view them as part of nature, as one phenomenon of nature among others.

However, if we want to be more specific it is necessary first to state explicitly what we mean by naturalization since the term naturalization can mean different things to different peoples. For us, to naturalize X is to bring X back to nature. By "nature" we do not mean anything philosophically sophisticated but only the object of study of the natural sciences, that is, of physics, chemistry, and biology. Therefore, to naturalize X is to bring X back to the natural sciences. To bring X back to the natural sciences includes the following:

(a) to study X by using the same concepts used by the natural sciences or concepts which are defined in terms of the concepts used by the natural sciences;
(b) to analyze X as constituted by mechanisms and processes of a quantitative nature and in which physical causes produce physical effects;
(c) to reconstruct the historical emergence of X from a preceding state in which X was nonexistent.

Hence, to naturalize humans is to study humans using the concepts of the natural sciences, to analyze them as constituted by quantitative mechanisms and processes in which physical causes produce physical effects, and to reconstruct the emergence of humans from a preceding state in which humans did not exist. Humans have not been studied in this way up to now. Therefore, the naturalization of humans remains a task for the future. However, it is possible today for the first time to outline a concrete and detailed research program aimed at the naturalization of humans.

The naturalization of humans is first of all the naturalization of the human mind but it includes also the naturalization of the products of the human mind, that is, of culture, society, history, literature, art, religion, philosophy, science.

## 2. The naturalization of mind

The concept of mind is the key concept used to set humans apart from the rest of reality, to view them as "special". Only humans have mind (at least human mind) and mind is completely different from the rest of the natural world. The dualism between mind and brain (or body or nature) is very ancient but is has been revived in a new form by contemporary "cognitivism". Cognitivism is the conception of mind as manipulation of symbols according to symbolically formulated rules. Cognitivism takes its inspiration from by the computer, which is a machine that manipulates symbols (data structures) according to symbolically formulated rules (the program). The computer is a dualistic machine, being composed by a hardware and a software. The hardware is conceptually independent from the software, and in fact the hardware is studied, designed, and realized by (some sub-disciplines of) physics whereas the software is studied, designed, and realized by computer science. Physics and computer science are reciprocally independent disciplines. No knowledge of physics is necessary to design good software and no knowledge of computer science is necessary to design good hardware. Cognitivism rests on the analogy between humans and computers. The mind is the software and the brain is the software of the "human computer". As a consequence, mind is completely set apart from physical nature (the brain or body) and it should be studied with a conceptual apparatus which is different and completely independent from the conceptual apparatus used by the natural sciences to study nature. If this is cognitivism, to naturalize mind requires, first of all, the rejection of cognitivism.

As we have said, however, the term naturalization means different things to different people. Another conception of naturalization, different from our conception, is that to naturalize X is to study X by formulating explicit or formal theories, models, principles concerning X, to draw particular inferences and predictions from these theories and models, and then to test these inferences and predictions against an explicit set of empirical data. In our view this is a definition of science, or of scientific method, not of naturalization. Our definition of naturalization is more restricted and it involves an explicit reference to the natural sciences with the three criteria (a)-(c) stated in the preceding section. Cognitivist theories, e.g., theories in generative linguistics and in much of current psychology and cognitive science, may be "scientific" but they are not naturalistic. In fact, since these theories adopt a conceptual vocabulary completely independent from the conceptual vocabulary used by the natural sciences to describe, analyze, and explain physical nature, they are a most explicit example of a non-naturalistic approach to the study of mind.

Cognitivist theories can even be criticized for not being really scientific. Science has the goal to construct a unified picture of reality. Given the aims of science, a unified picture of reality is to be preferred to a picture in which reality is a mosaic of different and conceptually unrelated phenomena because a unified picture implies a simpler and more restricted set of concepts to account for the whole of reality and the possibility to connect the different classes of phenomena exhibited by reality and to explain one class of phenomena in terms of other classes. In fact, what gives science much of its strength is the progressively unified picture of reality that science is demonstrably able to construct. If this account of the nature of science is correct, then cognitivism with its rigid separation between the concepts to be used to study mind and the concepts to be used to study nature (brain, body, etc.) is, from this point of view, unscientific.

The naturalization of mind implies the adoption of concepts and modeling tools to study behavior and cognition that are of the same type of those used by the natural sciences. Neural networks are such concepts and modeling tools. A neural network is a computer model of behavior and cognition which is directly and explicitly inspired by the physical structure and way of functioning of the nervous system. Let us see why this is true.

A neural network is a set of units (neurons) that influence each other through unidirectional connections (synapses between neurons). At any given time a unit has an activation level (firing rate of a neuron) which depends on the excitations and inhibitions arriving to the unit from other connected units. The influence that one unit has on another unit's activation level is a function of the activation level of the first unit and the "weight" (number of synaptic sites between the two neurons) and "sign" (plus for excitatory connections and minus for inhibitory connections) of the connection linking the first to the second unit. A typical neural network includes input units, output units, and internal units. The input units (sensors) encode in their activation pattern the current state of the physical and chemical environment just outside the organism. Their activation is propagated to the internal units and from the internal units to the output units while being gradually transformed by the weights of the connections linking each layer of units to the next one. The resulting activation pattern of the output units (motors) encode the movements with which the organism responds to the sensory input. In addition, a neural network can be influenced by the internal state of the body of the organism and respond with actions that modify this internal state.

The behavior of a neural network, i.e., the output with which the network responds to the input, is determined by the input and by the network's connection weigths (in addition to the network's architecture specifying which is unit is connected with which unit). Organisms learn by modifying their connection weights as a function of experience. If the experience of an organism in a particular environment changes the connection weights of the organism's neural network, the organism will respond to the same input with new outputs – generally more likely to promote the individual's survival/reproductive chances and welfare.

One model of learning in neural networks is the backpropagation procedure. One starts with a neural network with randomly assigned connection weights. Given the random weights, the network is initially unable to respond to the input in a useful way. In other words, the network initially lacks some desired capacity. In any given input/output cycle the network is informed from outside about what the desired response (output) to the input of that cycle should have been. The network compares its own output with the desired output (called teaching input) and, on the basis of the discrepancy between actual and desired output, modifies its connection weights in such a way that after a certain number of learning cycles the network's output approximates the desired output. In this way the network comes to possess a capacity that was initially absent.

Neural networks are an important step toward the naturalization of humans because they use the same kind of concepts as those used by the natural sciences, in particular the neurosciences. Of course, neural networks are theoretical models and, like all the theoretical models of science, they simplify with respect to the actual empirical phenomena. Therefore, we won't find in many neural networks all the details of real brains. But neural networks reproduce in a simplified form the structure and way of functioning of a physical organ, the nervous system, and this organ's physical interactions with a body-external and body-internal physical environment. Neural networks basically speak of physical causes producing

physical effects and of intrinsically quantitative mechanisms and processes: activation levels, activation levels caused by the state of the physical and chemical environment outside the network, activation levels caused by excitations and inhibitions arriving from other units, connection weights, changes in connection weights, etc. This is their basic vocabulary, completely identical in its physical and quantitative nature to the vocabulary of the natural sciences. Everything else must be defined in terms of this basic vocabulary.

Neural networks naturalize the mind in the sense that they don't assume there is something – the mind – that should be studied with concepts intrinsically different from the concepts of the natural sciences. But they do not "eliminate" the mind or, more precisely, mental life. Most animals have only a behavior. Humans – and in more primitive form other animals – have a mental life in addition to behavior. The type of neural networks we have described would be appropriate for the behavior of a simple organism. They map input from the external environment (or from inside the body) to output (movements) that change either the physical relation of the organism to external environment or the external environment itself (or the internal state of the body). However, the neural networks of more complex organisms, in particular humans, have a lot of recurrent connections, that is, internal circuits that produce self-generated input for the organism. The input that activates the network does not come from outside the network, from the external environment or from the body, but is self-generated by the network itself, and the network's output does not encode physical movements or changes in the body's internal state but self-generated input which is fed back to the network. This is the basis of mental life: mental images, rememberings, predictions, plans, self-directed inner speech, reasoning, thought. The "cognitive revolution" of cognitivism was a revolt against behaviorism and its denial of mental life. Neural networks do not deny mental life (or any other empirical phenomena). They simply claim that mental life can and should be analyzed and explained using a naturalized vocabulary.

Nor neural networks deny the existence of consciousness or, more correctly, of the variety of different phenomena that are usually referred to using the term consciousness. Consciousness phenomena are perfectly real empirical phenomena. The naturalization of humans does not imply in any sense their elimination. It only implies their naturalization. Here are some suggestions towards the naturalization of consciousness.

Some input to a neural network is public and some input is private. Public input is input whose physical origin is in the external environment outside the body of the organism and the same is true for the chain of physical causes and effects that connect the physical origin of the input to the physical events taking place in the neural network's input units and resulting in the particular pattern of activation of these units. An example is light reflected by an object to the retina of an organism. The object is outside the body of the organism and light travels in the external space from the object to the organism's visual sensors. Since both the origin of the input and the chain of physical causes and effect are in the external environment, approximately the same input can arrive to the input units of the neural networks of two different organisms and both organisms can manipulate the origin of the input and the chain of causes and effects (e.g., by removing the object or putting a screen in front of the object). This makes the input public and objective.

On the other hand, input arriving to the network's input units from inside the body of the organism is not public but private, simply because for physical reasons both the origin of the input and the chain of causes and effects leading from the origin of the input to the network's input units are inside the body of the particular organism and there is usually no way for another organism to receive an equivalent input from the same causes. This makes the input private, that is,

accessible only to the single organism. Furthermore, the origin and cause/effect chain inside the body that result in some input for an organism cannot be usually manipulated by the organism – which explains one sense in which this input is subjective.

Another aspect of consciousness is its phenomenal character as something which is felt or subjectively experienced. Feelings and emotions probably imply input to a neural network from inside the body but outside the nervous system. These inputs may have a motivational and attentional function, telling the organism which portions of the current input should be responded to and which portions should be ignored. Subjective states of feeling and emotion may represent the effort of particular motivations to win the competition with other motivation. They try to "speak louder" than others in order to "be heard" and those that speak loudest are subjectively felt.

On the other hand, not all phenomenal states are felt or emotional. Humans can have images and thoughts that are not necessarily emotionally charged. These phenomenal states do not involve motivational/attentional messages from the body but they are inputs self-generated inside the neural network itself. If the basic design of a neural network is a succession of layers transforming the sensory input followed by a succession of central internal layers followed by a succession of layers preparing the motor output, one can hypothesize that phenomenal states result from recurrent connections leading from the central and motor portions of the network to the sensory portion. In other words, phenomenal states necessarily involve a self-generated activation of the sensory portion of a neural network. In any case, no input from the external world by itself alone results in a subjective state. Simple organisms with simple neural networks without complex recurrent circuits do not have subjective states. They may respond to the yellowness of objects but they do not have a subjective experience of yellowness. Subjective states are more complicated. They may result from external input only if this external input causes the network to produce some self-generated input in the sensory portion of the neural network.

Using neural networks as modeling tools is a first critical step towards the naturalization of the human mind. But then these tools must be actually used to generate a naturalized account of typically human cognitive capacities such as language, the ability to predict future states, the ability to make plans, to reason, to remember the past, etc., and the phenomena of consciousness. But this is not enough. As stated in point (c) of our definition of naturalization (see Section 1), to naturalize X is also to reconstruct how X has emerged from a past in which X was nonexistent. Hence, to naturalize the human mind is to reconstruct how the cognitive capacities that are characteristic of the human species have emerged in the last 5 million years since the phylogenetic line of Homo sapiens has separated from the plylogenetic line of contemporary apes. This has been basically a process of biological evolution, even if social and cultural factors may also have played a role especially since the Upper Paleolithic (about 50.000 years ago). Hence, a naturalization of the human mind requires a recontruction of the biological evolution of the human mind and the availability of modeling tools to effect this reconstruction.

The naturalization of humans implies the recognition that humans belong to the natural world not only because they have a physical body and a physical nervous system but also because they inherit at birth a genotype which is the current result of a long process of biological evolution. The inherited genotype influences all the properties of the individual (phenotype). Genetic algorithms are modeling tools that can be used to capture this aspect of the naturality of humans. A genetic algorithm is a computer model of biological evolution (or, as we will see in the next Section, of any

kind of evolution). One starts with a population of variants (individual organisms) that have a finite lifetime and reproduce differentially; that is, some individuals leave more copies of themselves (offspring) in the next generation than other individuals. Furthermore, offspring are not identical to their parents. Evolution presupposes the existence of mechanisms for adding new variants to the population. In biological evolution the main mechanisms for adding new variants are genetic mutations and sexual recombination. Genetic mutations are random changes occuring in some portions of the inherited genotype when the genotype is transmitted from parents to offspring. Sexual recombination consists in producing a new genotype by combinaing together a portion of the genotype of one parent with the complementary portion of the genotype of the other parent. Differential reproduction and the mechanisms for adding new variants to the genetic pool result in evolutionary change in a succession of generations of a population. If differential reproduction selects the best individuals for reproduction, including new variants that represent improvements with respect to previously existing variants, evolutionary change can create new phenotypical traits and better adaptation to the environment. (However, one should not ignore the role played by adaptively neutral or even maladaptive evolutionary change which is due to a variety of factors.)

Any research that takes humans as its object of study in a naturalistic framework should include a consideration of the role of genetic information in determining the properties of human individuals, in particular their behavior, capacities, motivational tendencies, and mental life, and a consideration of the evolutionary processes that have resulted in the appearence of the species Homo sapiens from pre-human ancestors. Simulations using genetic algorithms have the advantage that they go beyond sterile and mostly ideological discussions of nature vs nurture and beyond weakly supported claims that this or that human capacity is innate. Genetic algorithms require that whatever is hypothesized to be genetically transmitted be formally encoded in an explicit and detailed way in simulated genotypes and that simulations demonstrate that such genotypes do actually emerge evolutionarily in populations of organisms living in explicitly described environments with explicitly stated selective pressures. Furthermore, the simulations must be able to show that typically human capacities cannot be simply acquired through experience but require the postulated genetic basis.

Hence, the naturalization of humans implies that one is able to reconstruct the evolutionary emergence of the human mind by doing simulations in which populations of organisms initially lacking such cognitive capacities as language, the ability to predict and plan, to reason, etc., and consciousness, gradually or more or less suddenly evolve these capacities. As we have said, this is a process of biologically evolution resulting in changes in inherited genotypes. However, genotypes evolve as adaptations to an environment and one cannot ignore that humans are characterized by a tendency to create their own social, cultural, and technological environment. Hence, the biological evolution of humans is intricately linked to their social, cultural, and technological evolution. We turn to these nonbiological evolutionary processes in the following Section.

## 3. The naturalization of culture

The naturalization of humans implies not only an explicit and detailed recognition of the rooting of humans in biological evolution but also a naturalization of other, nonbiological evolutionary aspects of humans. Humans are characterized by the fact that most of their behaviors and capacities are learned from conspecifics and that they live in an environment of artifacts which have been created by conspecifics. Hence, the naturalization of humans requires that

we are able to model how behaviors, capacities, and artifacts are culturally transmitted, how cultural transmission in humans is rooted in their genetic make-up, and how cultural, social, and technological environments are created by humans through transgenerational evolutionary processes similar, but not identical, to biological evolution.

A simple naturalized model of cultural transmission of behaviors and capacities is the following. Imagine two different neural networks that are exposed to the same input and that generate each its own output in response to the input. One of the two networks (the 'student') learns by taking the output of the other network (the 'teacher') as its teaching input in the backpropagation procedure (see above). The student modifies its connection weights in such a way that its response (output) to the input tends to become progressively more similar to the teacher's response. After a while, the student will respond to the input in the same way as the teacher. If the teacher initially possesses some capacity which is lacking in the student, at the end of learning the capacity will have been transmitted to the student. If the teachers are members of one generation and the student are members of the next generation, this mechanism of cultural transmission through behavior and learning (and not through the copying of genotypes as in biological transmission) will cause the reproduction of behaviors and capacities across a succession of generations.

The genetic algorithm can be used to model not only biological evolution but also cultural evolution. Imagine that teachers are selected among the best individuals of the previous generation and that cultural transmission is modified by mechanisms that add new variants to the pool of culturally transmitted behaviors and capacities. This can lead to cultural evolutionary change and the appearence of new culturally transmitted behaviors and capacities.

Similarly, the cultural transmission of artifacts can be simulated by having neural networks of one generation copy the artifacts of the preceding generation. The properties of a model artifact, chosen among the artifacts used by the neural networks of the previous generation, are encoded in the input units of a neural network of the next generation and the network learns to produce a new artifact which is a copy of the model artifact. This can be done by interpreting the network's output as encoding the properties of the new artifact and using the properties of the model artifact as teaching input in the backpropagation learning procedure. If the artifacts to be used as models to be reproduced by the next generation are selected from among the best artifacts of the previous generation, i.e, those leading to the greatest increase in the survival/reproductive chances of the organisms using them, and furthermore, there are mechanisms that in each generation add new variants to the pool of artifacts, the net result is a progressive improvement of the artifacts used by the population of neural networks.

In the simulations we are describing the introduction of new variants to the pool of culturally transmitted behaviors or artifacts is obtained by simply adding some random noise to the teaching input. Therefore, a reproduced behavior or artifact may not be identical to the original and the copies may, even if rarely, be better than the originals. However, cultural transmission may also have the equivalent of sexual recombination in biological evolution, with new behaviors and artifacts resulting from combining together the properties of two or more originals of the previous generation. Furthermore, unlike genetic evolution, cultural evolution may result not from random errors of transmission but from intentional invention based on typically human abilities such as the ability to predict and plan.

Another important difference between biological and cultural/technological evolution is that while in biological evolution the agent that selects the variants for reproduction is a generally static "nature" (natural selection), in

cultural/tecnological evolution the selective agents are the neural networks themselves, that is, the conspecifics (social selection). This implies a co-evolution of what is selected and the agent of selection, which makes for a much more complex process of evolution with an even more important role of adaptively neutral or maladaptive change than is true for biological evolution.

## 4. The naturalization of history

The knowledge and explanation of the past is crucial for the naturalization of humans because, as we have said in Section 1, the naturalization of humans implies that we are able to reconstruct how humans have emerged from a past in which there were no humans. Hence, a basically historical and genetical orientation is an essential element in our naturalization program. However, the naturalization of humans implies a very different approach to the study of the past with respect to traditional approaches.

The history of human societies, i.e., the description of the various human societies of the past and of how they have changed in the course of time, is traditionally the province of the discipline called history. The naturalization of humans implies the naturalization of history. What is the naturalization of history?

Traditionally history is distinguished from other historical disciplines such as prehistory, protohistory, archaeology, and philology. While history studies past human societies that we can know through the written texts they have produced, prehistory is the study of human societies that existed before the introduction of writing. Protohistory is the study of peoples during their transition from prehistory to history. Archeology is the study of human artefacts of the past that are not written texts (buildings, tools, etc.). Philology is the study of the written texts produced by past societies.

All these distinctions do not exist in a naturalized history. Naturalized history is the scientific study of past human societies and it does not make any distinction between more ancient and more recent societies, between societies with writing and societies without writing, and between different types of empirical data (e.g., written texts vs other kinds of artefacts) that can be used to reconstruct and understand the past.

Naturalized history differs from traditional historical disciplines not only because it rejects the traditional division of labor among different historical disciplines but because it has a different conception of its task. Traditional history is often just a narrative of past events. It aims at reconstructing as accurately as possible the past but with self-imposed limits when it comes to explaining it. On the contrary, a naturalized history has as its primary objective to understand/explain the human societies of the past. The collection and analysis of historical facts and the description of successions of events is only instrumental in view of this primary objective. The facts of the past are the empirical evidence of the discipline and as such they must be known as completely, accurately, and objectively as possible. But naturalized history is less “narrative” and more “theories and models” that try to explain what happened in the past and why, with empirical data and narratives playing the role of starting points for formulating theories and models and of empirical evidence to confirm or disconfirm them.

Another, even more crucial, aspect of naturalized history which distinguishes it from traditional history is that naturalized history rejects the separation between the past of human societies and the past of the rest of reality which is

almost foundational for the traditional historical disciplines. These disciplines study the past in that it is restricted to human societies, with the assumption that human societies and the rest of reality have a 'past' in a very different sense. On the contrary, naturalized history makes no distinction between the study of past human societies and the study of the past of all reality. Naturalized history extends to the history of living species on Earth prior to the appearence of the species Homo sapiens or of the genus Homo, and therefore it includes evolutionary biology. Beyond that, naturalized history includes not only the history of life on Earth but also the history of the entire universe before the appearence of life.

The emphasis on explanation and the extension of the study of the past to all reality point to an even deeper difference between naturalized history and the traditional historical disciplines, a difference in how to conceive the relationship between human history and the natural sciences. Traditional historical disciplines regard themselves as very different from the natural sciences. This difference may be expressed as a contrast between Naturwissenschaften and Geisteswissenschaften, between natural sciences and historical sciences, between sciences concerned with explanation and sciences concerned with understanding (interpretation, hermeneutics), between sciences that aim at formulating general laws and sciences that try to capture and interpret unique events and conditions. In contrast, naturalized history sees no difference between history and the natural sciences. Naturalized history is knowledge/explanation of the past of human societies as part of the past of all reality and of how human societies have changed in the course of time based on an analysis in terms of natural causes and effects and of mechanisms and processes of an intrinsically quantitative nature.

Finally, naturalized history rejects the separation between history and the other social sciences. The study of human societies is traditionally subdivided into the diachronic or historical disciplines that study past human societies and how they have changed in the course of time, and the synchronic disciplines, the social sciences that study various aspects of society in a sort of atemporal perspective (which in practice means to study modern Western societies), i.e., sociology, economics, political science. This division of labor has been an even more serious obstacle to our understanding of humans than the division of labor among the different historical disciplines already discussed. The naturalization of history implies a complete fusion of diachronic and synchronic perspectives in the study of human societies.

## 5. The naturalization of the products of human behavior and mind

Humans are typical not only for having a mental life in addition to an external behavior and for being involved in a very complex process of cultural transmission and historical change but also for creating such historical products as art, religion, philosophy, and science. No naturalistic account of humans can be complete unless it includes a naturalistic account of art, religion, philosophy, and science.

Since art, religion, philosophy, and science play a critical role in fostering a conception of humans as "special" (that is, special in a special sense), it is to be expected that they will tend to resist such an account. Humans are often considered as "special" just because they have art, religion, philosophy, and science. A naturalistic account of these products of humans would therefore constitute a critical blow to the conception of humans as "special". Furthermore, art, religion, philosophy, and even science (at least the cognitive and social sciences) implicitly assume or even explicitly maintain

that humans are “special”. Hence, a naturalistic account of humans will inevitably involve important changes in the character of these human products.

But what is a naturalistic account of art, religion, philosophy, and science? To answer this question we should go back to our three defining criteria for naturalization (see Section 1): (a) the use of concepts basically identical to those used by the natural sciences; (b) an analysis in terms of quantitative processes of physical causes and effects; (c) the reconstruction of the historical emergence of whatever is to be naturalized from a previous state in which it was still nonexistent. What is meant by a naturalization of art, religion, philosophy, and science is an account of these human products based on these three criteria. This is clearly a very complex and difficult task. Almost nothing which is said, written, and thought about art, religion, philosophy, and science (with perhaps the partial exception of science) is even remotely close to taking these three criteria into consideration. Art, religion, philosophy, and science normally develop on the basis of purely internal criteria whereas naturalization critically implies an external point of view on humans and their products. In fact, while humans sofar have been viewed by humans from within and we have had mainly an “endo-science” of humans, the naturalization of humans aims at creating an “eso-science” of humans.

What we would like ideally to have are simulations of populations of organisms that start without art, religion, philosophy, and science, and, given the appropriate conditions, start producing art, religion, philosophy, and science. The important question is: What are these conditions? Using naturalized models of the human mind such as neural networks and of processes of biological and cultural evolution such as genetic algorithms (cf. Sections 2 and 3) should make the naturalization task easier. Then we should be able to reproduce the historical development of art, religion, philosophy, and science. Why art, religion, philosophy, and science have emerged in some places and times and not in others and why they have undergone the process of historical development they have undergone? An “endo-science” of humans sofar has practically ignored questions of evolutionary origins of these human products and has written purely internal histories. (For example, histories of philosophy are written only by philosophers.) The naturalization of art, religion, philosophy, science (but also of morality, social and political institutions, etc.) requires that questions of evolutionary emergence be taken seriously and histories be written from outside.

Even if the naturalization of the cultural/historical products of the human mind is even more a task for the future than the naturalization of the human mind itself and of the basic processes of cultural evolution, the naturalization of humans is emerging today in the awareness of a growing number of researchers as an important and feasible enterprise. Neural networks are naturalized computer models of the human mind (Rumelhart and McClelland, 1986) and genetic algorithms are naturalized computer models of evolutionary processes, both biological and cultural (Holland, 1992). Important formal/quantitative models of cultural transmission and evolution have been published (Cavalli-Sforza and Feldmann, 1981; Boyd and Richerson, 1985). Artificial Life, which aims at studying all phenomena of the living world by reproducing these phenomena in artificial systems, is based on the idea of complexity as a unified theoretical framework that in principle eliminates any “specialness” of humans (Langton, 1995). Furthermore, in recent years a growing number of books have been dedicated to exploring various aspects of the naturalization and evolution of art (Dissanayake, 1992; forthcoming; Carroll, 1995; Simonton, 1999) and religion (Hinde, 1999) while evolutionary psychology and psychiatry have tried to explore the evolutionary underpinnings of human capacities and motivations (Barkow, Cosmides, and Tooby, 1995; Buss, 1999) and of psychiatric disorders (Stevens and Price, 1996; McGuire and Troisi, 1998).

## 6. Conclusion

The naturalization of humans is a task for the XXI century but at the end of XX century one can see the emergence not only of the idea of a naturalized science of humans but also of the technical tools that will make the translation of this idea into practice possible. Neural networks, genetic algorithms, and Artificial Life models are some of these tools. Other tools of a more general nature that will turn out to be decisive steps towards the naturalization of humans are the theoretical tool of complex systems theory and the methodological tool of computer simulations. Complex systems theory is a very general theoretical framework that analyzes very different kinds of phenomena as resulting from the local interactions of large numbers of elements in such a way that, even if the global properties of a system are determined by the local interactions of its elements, these global properties cannot be predicted or deduced from a knowledge of the elements and of the rules that govern their interactions. Simulations are a new way of expressing scientific theories and models. Traditionally, scientific theories and models are expressed using some symbolic medium such as more or less systematized portions of ordinary language and the quantitative language of mathematics. Simulations are scientific theories and models that are expressed as computer programs. Since a program can run in a computer, simulations are 'active' theories and models. By running in the computer a simulation can explicitly demonstrate if it is able to actually reproduce the phenomena that the theory or model was intended to explain. Furthermore, since the researcher can manipulate the variables of the simulation and observe the results of these manipulations, a simulation functions as a virtual experimental laboratory.

The naturalization of humans as we have described it in this paper may appear to be a reductionist, mechanicist, and scientist research program. But in fact it is not reductionist, mechanicist, or scientist. It is not reductionist because, even if it assumes that connecting different types of phenomena (high level phenomena with lower level phenomena but also the other way round) is crucial for the purposes of science, the theoretical framework of complex system rules out the possibility that higher level phenomena can be predicted or deduced from a knowledge of lower level phenomena. It is not mechanicist because while mechanical devices ('machines') are simple systems made up of a small number of parts that predictably produce the overall performance of the system and that play recognizable role in the overall performance of the system, most systems that make up reality, including all human phenomena, are not 'machines'. It is not scientist because it does not assume that science is the only or the best way of knowing and relating to reality.

Although the naturalization of humans is a research program that holds the promise of substantially increasing our scientific understanding of humans, it will have to overcome many obstacles in its way to success. First, it is an intrinsically complex and difficult research program. This is too obvious to require discussion. Second, it will meet strong resistence both in the culturally inherited conception of humans (and in the way humans <u>want</u> to conceive themselves) and in the traditional scientific disciplines that take humans as their object of study. Third, it will meet strong resistence on the part of philosophers. The naturalization of humans is a purely scientific research program completely integrated into the natural sciences. At the end of the XX century philosophy has accepted that the study of nature is the province of science, not philosophy. But the naturalization of humans implies that even the study of humans escapes philosophy and becomes a purely scientific enterprise. This cannot be easily accepted by philosophy unless philosophy is willing to give up all claims of knowledge of reality. This explains why almost all philosophers today tend to side with cognitivism against neural networks in the study of mind and why consciousness phenomena

appear to the eyes of many philosophers as the last trench of a non-naturalized conception of mind. Even more opposition on the part of philosophers will be met by the research program we have described in this paper when the naturalization of humans will be extended to culture, history, art, religion, science and even philosophy itself.

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