Evolutionary Psychology and the Unity of Sciences:

Towards an Evolutionary Epistemology

Luís Moniz Pereira[1]

Abstract

This work concerns a non-traditional approach to the unity of sciences, based on a challenging, albeit conjectural, articulation of views proceeding from Evolutionary Psychology and Biology, non monotonic and decision Logics, and Artificial Intelligence.

The resulting amalgam sets forth a consilience stance, wherefore the unity of science is heuristically presupposed by means of a set of pragmatic and productive default assumptions. It is by virtue of them that we conduct scientific inquiry, the consilience arising from a presumed unity of objective reality, itself of a heuristic and pragmatic conception.

The attending hinges to Artificial Intelligence inevitably suggest the emergence of an innovative symbiotic form of evolutionary epistemology.

Keywords: Epistemology, Consilience, Evolutionary Psychology, Logics, Artificial Intelligence

1. Consilience

In his 1941 classic *Man on His Nature*, the British neurobiologist Charles Sherrington spoke of the brain as an enchanted loom, perpetually weaving a picture of the external world, tearing down and reweaving, inventing other worlds, creating a miniature universe. The communal mind of literate societies – world culture – is an immensely larger loom. Through science the brain has gained the power to map external reality far beyond the reach of a single mind, and through the arts the means to construct

[1] Email: lmp@di.fct.unl.pt
Centro de Inteligência Artificial – CENTRIA
Departamento de Informática, Faculdade de Ciências e Tecnologia
Universidade Nova de Lisboa – UNL
2829-516 Caparica, Portugal

narratives, images, and rhythms immeasurably more diverse than the products of any solitary genius. The loom is the same for both enterprises, for science and for the arts, and there is a general explanation of its origin and nature and thence of the human condition, proceeding from the deep history of genetic evolution to modern culture. Consilience of causal explanation is the means by which the single mind can travel most swiftly and surely from one part of the communal mind to the other.

Arguments in favour of the unity of knowledge – consilience – have been strongly put by Edward O. Wilson, a creator of sociobiology, and author of *Consilience – The Unity of Knowledge* (1988). He postulates there is a single physical nature, and one not persuadable through argumentation or persuasion, whatever the deconstructionists may think. Science is not mere convention.

Consilience, according to him, is the result of co-evolution involving (cultural) memes and genes (see below). Our cultural memes have a genetic basis and cannot, in the long run, stand against the genes who guarantee their survival, although such attempts may potentially exist – viz. through genetic manipulation.

On the other hand, we have several different cultures, though these are produced by brains which have evolved to solve similar problems in ancestral times and, as such, cannot be exceedingly different or distant. Consilience puts in check the romantic conception of the mind as a *tabula rasa* and condones not artistic «irreducibility». In the latter conception there a special something which cannot be reduced or converted to anything else, and, as such, prevents science from addressing the realm of art, even if art itself is the product of a brain which has been evolving for millions of years. Consilience considers scientifically approachable human universals, and that way opens a passageway to that missing link between science and art.

2. Evolution and the Brain

The first bipedal primates establish the separation between the human species and the other simians. To fathom the abilities of the human brain it is necessary to understand what exactly were the problems our ancestor primates were trying to solve that led them to develop such an extraordinarily intricate brain. We cannot look at the modern human brain, and its ability to create science, as if the millions of evolution-years which attuned it to its present configuration had never taken place. Among the eventual problems we certainly have those of status, territorialism, mating, gregariousness, altruism versus opportunism, the building of artefacts, and the mappings of the external world.

To the *Homo Sapiens Sapiens*' brain, considered indistinguishable from our current one, we assign an estimated an age of one or two hundred thousand years. The Palaeolithic started at about 60 or 30 thousand years before that, the period in which language, and much later writing, began to develop.

By the Upper Palaeolithic times however, from 40,000 to 10,000 before the present, the tempo of cultural evolution quickened dramatically. According to the theory of population genetics, most of the change was far too fast to be tracked closely by genetic evolution.

As the psychiatrist must look at a patient's past in order to better understand him in the present, so must we look also at our species' past in order to understand our modern peculiarities. This stance is called Evolutionary Psychology – a fascinating field of study – born some 40 years ago.

Evolutionary Psychology is a consummate example of successful ongoing scientific unification, engendered by a deeply significant combination of Psychology, Anthropology, Archaeology, Evolutionary Biology, Linguistics, Neurosciences, and Artificial Intelligence (David M. Buss, 2005).

Evolutionary Psychology has been studying the brain from the evolutionary perspective, thereby originating some extremely relevant contributions. In that perspective, it has been strongly supported by Anthropological Archaeology in its empirical study of the cultural evolution of mankind (Stephen Shennan, 2002).

3. Evolutionary Psychology: Genes and Memes

In human life, we have two reproductive mechanisms: one is sexual reproduction, in which the replication unit is the gene; the other is mental reproduction. Some authors from Evolutionary Psychology have construed the notion of “meme”, in complement and contrast to the gene. A meme is that which substantiates a second reproductive system executed in the brain. It is the mental unit corresponding to the gene. Memes gather in assemblies, in patterns, similar to the way genes gather in chromosomes. Memes are patterned by ideologies, religions, and common sense ideas. Indeed, certain memes work well together, mutually reinforcing each other, others not, so that correcting (and correctional) mechanisms may be triggered.

We have a genetic reproduction system and, on top of it, Nature – through evolution – has created a second one, which we employ in pedagogy. We reproduce ideas: generally, good ideas propagate and replicate, being selected over the bad ones, although no one is around to guarantee it.

Genes persist because they reproduce, and memes are the reproduction units associated with the brain – the brain being a reproductive organ. What we are doing, in schools and universities, is to reproduce knowledge. Educational systems consist of a means for «infecting» students with good memes, ideas having proven themselves able enough to self-reproduce and persist, while despising others that fail to survive. There are however different variants of educational systems, for instance madrasas.

When they interact, people communicate ideas, and those which are infectiously good tend to reproduce. There are assemblies of ideas, sets of beliefs, which reproduce together. The memes in such memeplexes – like the genes in chromosomes – are in competition amongst themselves and also with the gene base. They exist because they are part of a reproductive mechanism which is necessary to achieve faster local adaptations, as genes take too long to reproduce with respect to the time scale of the individual bearing the memes. Thus the individual phenotype may be given more of a chance to reproduce its genotype. This leads directly to the meme-gene co-evolution.

Memes however could not spread but for the biologically valuable tendency of individuals to imitate, something afforded by the brain. There are plenty of good reasons why imitation should have been favoured by conventional natural selection working on genes. Individuals that are genetically predisposed to imitate enjoy a fast track to skills that may have taken others a long time to build.

Consequently, the brain and its accompanying mind are the result of a deep symbiosis, a genetic product influenced by the mechanism of memetic reproduction. In this faster system of adaptation we have reached the point of being able to predict our own memetic (and genetic) mutations, as necessary changes to prepare for the future by anticipating it. That is why we imagine the future – we create hypothetical scenarios, predict the possible futures, and choose to pursue some of them. This is the basis of the battleground of free will, a useful product of evolution – the ability to imagine scenarios and prefer among them through enacting choices.

However, beyond simple reproductive success there are also pressing concerns in regard to social interaction. As communal beings, we need to develop some sort of status in order to be respected, copied, or obeyed. We must worry about territorial expansion and its defence, if we are to have descendants and, moreover, descendents with descendents. We need to sign contractual agreements with those who share our social and cultural ecology. There is also the important requisite of personal expression opportunity. If we do not express ourselves, no one will copy even our dearest memes, let alone our scientific theory memeplexes.

In this view, scientific thought emerges from distributed personal interaction, albeit it at a special and temporal distance, and never in an isolated way. It must be erected from several confluences, or in teams, as is the case in science. In truth, knowledge is not constructed in an autonomous way; rather it is engendered by networks of people. In science it is important to work as a team. The stereotype of the isolated and enlightened aristocratic scientist has been defeated for quite some time: science is institutionalized, organized and has proper methodologies, conferences. It is processed in appropriate environments, one of them being the educational one, in which we carry out *memetic* proliferation.

Language is the instrument which allows us to fabricate knowledge together, because there is no isolated thought. We go so far as to state that there is no isolated consciousness, that all consciousness is distributed. In particular, any idea of a genius-like isolated consciousness is a myth. When we consider consciousness we should take it out of the brain and spread it through culture, and this is the importance of language.

4. Specific Modules versus General Intelligence

Theoretical and field archaeologists, like Steven Mithen in *The Prehistory of Mind* (1996), are bringing in historical and pre-historical evidence that our ancestors began with a generic intelligence, such as we find in apes.

There has been a broad discussion – in fact reproduced within the Artificial Intelligence (AI) community – about whether intelligence is a general functionality or else best envisaged as divided into specific ability modules or components. When it first

appeared, Evolutionary Psychology developed a trend, which Chomsky had begun in insisting on innate specialized areas for language processing in the brain, and it was generally accepted that a plethora of specific modules for a diversity of certain brain functions do exist. Indeed, in the beginnings of Evolutionary Psychology, people like Steven Pinker, Leda Cosmides, John Tooby, and David Buss, in consonance with AI's own vision of specific modules, believed that all brain functions were founded on such modules – there would be modules for language, for mating, religion, etc.

Meanwhile, archaeologists have come to demonstrate, through their historical records, that human species went from a first phase of general intelligence to a second phase of three major specialized modules: one for natural history and naive physics (knowledge of Nature); the one for knowledge and manufacture of instruments; and one for cultural artefacts, i.e. the rules of living in society and the very politics of coexistence.

These three specialized intelligences were separated, and it is only at a newer stage – corresponding to *Homo Sapiens*, with the appearance of spoken language – that it becomes necessary to have a cupola module, articulating the other modules. How else do the different specialized modules connect, and how can people communicate amongst themselves? That need gave birth to the generic cupola module, a more sophisticated form of general intelligence, the cognitive glue bringing the specialized modules to communicate and cooperate.

5. The Evolution of Reason: Logic

The formal systems of logic have ordinarily been regarded as independent of biology, but recent developments in evolutionary theory suggest that biology and logic may be intimately interrelated. William S. Cooper (2001) outlines a theory of rationality in which logical law emerges as an intrinsic aspect of evolutionary biology.

This biological perspective on logic, though at present unorthodox, could change traditional ideas about the reasoning process. Cooper examines the connections between logic and evolutionary biology and illustrates how logical rules are derived directly from evolutionary principles, and therefore have no independent status of their own. Laws of decision theory, utility theory, induction, and deduction are reinterpreted as natural consequences of evolutionary processes. Cooper's connection of logical law to evolutionary theory ultimately results in a unified foundation for an evolutionary science of reason.

According to Cooper, today, in the general drift of scientific thought, *logic* is treated as though it were a central stillness. For the most part, the laws of logic are taken as fixed and absolute. Contemporary theories of scientific methodology are logico-centric. Logic is seen commonly as an immutable, universal, meta-scientific framework for the sciences, as for personal knowledge. Biological evolution is acknowledged, but it is accorded only an ancillary role, as a sort of biospheric police force, whose duty is to enforce the logical law among the recalcitrant. Logical obedience is rewarded and disobedience punished by natural selection, it is thought. All organisms with cognitive ability had better comply with the universal laws of logic on pain of being selected against!

Comfortable as that mindset may be, Cooper believes he is not alone in suspecting it has things backward. There is a different, more biocentric, perspective to be considered. In the alternative scheme of things, logic is not the central stillness. The principles of reasoning are neither fixed, absolute, independent, nor elemental. If anything, it is the evolutionary dynamic itself that is elemental. Evolution is not the law enforcer but the law giver – not so much a police force but a legislature. The laws of logic are not independent of biology but implicit in the very evolutionary processes that enforce them. The processes determine the laws.

If the latter understanding is correct, logical rules have no separate status of their own but are theoretical constructs of evolutionary biology. Logical theory ought then in some sense to be deducible entirely from biological considerations. To paraphrase, the hypothesis is that the commonly accepted systems of logic are branches of evolutionary biology.

Indeed, evolution has provided humans with symbolic thought, and symbolic language communication abilities. Objective common knowledge requires thought to follow abstract, content independent rules of reasoning and argumentation, which must not be entirely subjective, on pain of making precise communication and collective rational endeavour impossible. Such rules have become ingrained in human thought, and hold an enormous joint survival value.

In human cognitive evolution, both mimetic knowledge (such as that inherent in reality-simulating maps and models), and imitation knowledge (such as that present in ritual observation, or in artefact reproduction), were essential first steps towards socially situated, joint rule following behaviour, required by, say, hunting plans.

Decision theory is the branch of logic that comes into most immediate contact with the concerns of evolutionary biology. They are bound together by virtue of their mutual involvement in behaviour. The logic of decision is concerned with choices regarding the most reasonable courses of action, or behavioural patterns. Behaviour is observable, it is amenable to scientific prediction and explanation, and there is the possibility of explaining it in evolutionary terms. This makes behaviour an interdisciplinary bridge approachable from both the biological and the logical sides. Ultimately, behaviour is the fulcrum over which evolutionary forces extend their leverage into the realm of logic. Viewed through the lenses of biology, favoured behaviour is evolutionary fit. Through the lens of logic it is rational decision behaviour (Cooper, 2001), according to rules for reasoning and rules for action.

On the heels of rational group behaviour, throughout human cultures there emerged abstract rule following social games. Game rules encapsulate concrete situation defining patterns, and concrete situation-action-situation causal sequencing, which mirrors causality-obeying physical reality. From games, further abstraction ensued, and there finally emerged the notions of situation-defining concepts, of general rules of thought and their chaining, and of legitimate argument and counter-argument moves. Together they compose a cognitive meta-game (John Holland, 1998).

The pervasiveness of informal logic for capturing knowledge and for reasoning, a veritable *lingua franca* across human languages and cultures rests on its ability to actually foster rational understanding and common objectivity. Crucially, objective

knowledge evolution dynamics, whether individual or plural, follows ratiocination patterns and laws.

Furthermore, and more recently, the very same rules of reasoning can and are employed to reason about reasoning. Moreover, new reasoning methods can and have been invented and perfected throughout human history. Examples of these are transfinite induction, *reductio ad absurdum* (proof by contradiction), recursion, abduction, and contradiction removal, to name but a few.

Though some reasoning methods are well known, some are still unconscious but, like the rules of grammar, can be discovered through research. Indeed, humans can use language without learning grammar. However, if we are to understand linguistics, knowing the logic of grammar, syntax and semantics is vital. Humans do use grammar without any explicit knowledge of it, but that doesn't mean it cannot be described. Similarly, when talking about the movement of electrons we surely do not mean that a particular electron knows the laws it follows, but we are certainly using symbolic language to describe the process, and it is even possible to use that description to implement a model and simulation which exhibits precisely the same behaviour.

New purported reasoning methods may be disputed, just like any specific train of reasoning can. But reasoning can only be disputed by further reasoning, if any consensus is to be found! (Thomas Nagel, 1997). Some argue that scientific and philosophical discussion is necessarily a tantamount to a culture sensitive, and culturally relative, persuasive informal *ad hoc* argumentation, allied to anything goes rhetoric (criticized by Paul Gross, Norman Levitt, 1994). They ignore that argumentation is just another form of reasoning which has itself been made the subject of logical formalization, and are oblivious to the fact that rhetoric may be fine for preachers, but is not conducive to the two-sided communication required to reach common agreement in the all rigorous scientific praxis that lead to cumulative knowledge.

Logic, we sustain, provides the overall conceptual cupola that, as a generic module, fluidly articulates together the specific modules identified by evolutionary psychology. In that respect, it is mirrored by the computational universality of computing machines, which can execute any program, compute any computable function.

The relationship of this argument to logic is ensured by the philosophical perspective of functionalism: logic itself can be implemented on top of a symbol processing system, independently of the particular physical substrate supporting it. Once a process is described in logic, we can use the description to synthesize an artefact with those very same properties. As long as it is a computational model, any attempt to escape logic will not prove itself to be inherently more powerful.

On the other hand, there is an obvious human capacity for understanding logical reasoning, a capacity developed during the course of brain evolution. Its most powerful expression today is science itself, and the knowledge amassed from numerous disciplines, each of which with their own logic nuances dedicated to reasoning within their domain. From nation state laws to quantum physics, logic, in its general sense, has become the pillar on which human knowledge is built and improved, the ultimate reward for our mastery of language.

6. Realism and the Unity of Sciences: Our Stance

Belief in the intrinsic unity of knowledge, whatever may be its reliance on logic, rides ultimately on the hypothesis that every mental process has a physical grounding and is consistent with the natural sciences. The mind is supremely important to the consilience program for a reason both elementary and disturbingly profound. Everything that we know and can ever know about existence is created or absorbed there.

We partake of a species which evolved a brain that copes with its doubly situated existence in nature and nurture. And in this endeavour it is enabled by the wherewithal in jointly modelling and changing both one and the other. The universal plasticity and the mimetic ability of the human mind account for its success in striving for and achieving consilience.

Nevertheless, all that has been learned empirically about evolution in general, and mental processes in particular, suggests that the brain is a machine assembled not to understand itself, but to survive. Understanding the mind at work, then, needs to be brought about by the methods of science.

The human attainment of high intelligence and culture ranks as the last four great steps in the grand history of life. They followed one upon the other at roughly one-billion-year intervals. The first was the beginning of life itself, in the form of simple bacteriumlike organisms. Then came the origin of the complex eukaryotic cell through the assembly of the nucleus and other membrane-enclosed organelles into a tightly organized unit. With the eukaryotic building block available, the next advance was the origin of large, multicellular animals such as crustaceans and molluscs, whose movements were guided by sense organs and central nervous systems. Finally, there came humanity and its cortex, with the ability to perform science and to change the world.

However, what we know of the heredity and development of the brain shows them to be almost unimaginably complicated. The human genome database reveals it to be comprised of over 30,000 genes, with at least over 3,000 distinct ones. The molecular processes that guide the growth of neurons to their assigned places have only begun to be deciphered. Overall, the human brain is the most complex object known in the universe.

Notwithstanding, here is this paper's stance on the Unity of Sciences:

- At some point, it seems a materialist pragmatic heuristic to believe, i.e. to introduce a default postulate, to the effect that a unifying consilience of mind and body will be met.

- Furthermore, we are entitled to pragmatically and heuristically presuppose that the brains we have in common, received via ancestral evolution, are indeed capable of ever extendable joint agreement regarding the scientific view of our shared reality, especially in view of our brains' plasticity of communication and modelling.

- Finally, we can pragmatically, and for efficiency's sake, assume that the very unity of mind-independent reality (a presumed given) is thereby conducive to the unity of the sciences themselves.

These productive and tenable working assumptions have yet to be disproved (even in spite of postmodernism...) and so we keep to them. Let us dub the position that goes with them "Evolutionary Pragmatic Epistemological Realism", inspired by Nicholas Rescher's *Realism and Pragmatic Epistemology* (2005).

And we presume thence a mind-independent reality for at least six important reasons:

- To preserve the distinction between true and false with respect to factual matters and to operate the idea of truth as agreement with reality.
- To preserve the distinction between appearance and reality, between our *picture* of reality and reality itself.
- To serve as a basis for intersubjective communication.
- To furnish the basis for a shared project of communal inquiry.
- To provide for the fallibilistic view of human knowledge.
- To sustain the causal mode of learning and inquiry and to serve as a basis for objectivity of experience.

What is at stake in the present stance is ultimately a principle of practice, and thought practice to be sure. Accordingly, the justification for our fundamental presuppositions is not *evidential* at all; postulates as such are not based on evidence. Rather, it is practical and instrumentalistic – pragmatic, in short. It is procedural or functional efficacy that is the crux. The justification of these postulates lies in their utility: we need them to operate our conceptual scheme. Consequently, our unity of science stance's epistemic status is not that of an empirical discovery but of an encompassing presupposition whose ultimate justification is a transcendental argument from the very possibility of communication and inquiry as we typically conduct them.

7. Postmodernism

Now turn we to postmodernism, the ultimate polar antithesis of the Enlightment. The difference between the two extremes can be expressed roughly as follows: Enlightment thinkers believe we can know everything, and radical postmodernists believe we can know nothing. The philosophical postmodernists challenge the very foundations of science and traditional philosophy. Reality, they propose, is a state constructed by the mind, not perceived by it. In the most extravagant version of this constructivism, there is no "real" reality, no objective truths external to mental activity, only prevailing versions disseminated by ruling social groups.

Postmodernism is expressed more explicitly still in "deconstruction", a technique of literary criticism. Each author's meaning is unique to him, goes the underlying premise; nothing of his true intention, or anything else connected to objective reality, can be reliably assigned to it. His text is therefore open to fresh analysis and commentary

issuing from the equally solipsistic head of the reviewer. But then the reviewer in turn is subject to deconstruction.

Patently, postmodernism puts itself into question in inescapable self paradox as a method to obtain secure knowledge, and is incompatible with scientific methodology. The latter relies on the existence of a regularity abiding external reality, which cannot be emotionally cajoled, and which is both human history and society independent.

8. Epistemic Tools

However, the canonical definition of objective scientific knowledge avidly sought by the logical positivists is not a philosophical problem nor can it be attained, as they hoped, simply by logical and semantical analysis. It is an empirical question too, that can be answered only by a continuing probe of the possible functionality of the thought process itself and its physical basis.

In some cases, the cognitive tools and instruments of rationality will be found hardware independent. Even then, the appropriateness of their use in specific real circumstances and goals will need to be empirically determined. There is no universal one-size-fits-all epistemological recipe, but agreement can be had on the relative success of any given tool kit.

In any case, partial understanding may also be sought by building intelligent machines, functionalism coming to the rescue when positing that the material substrate is often not of the essence, that it suffices to realize equivalent functionality albeit over different hardware. Moreover, distinct functioning roads to the same behaviour may be had, thereby accruing to our understanding of what general intelligence means, toward their symbiotic entwining, the most recent step in evolutionary epistemology. Functionalism can only make that more adroit.

The most fruitful procedures will almost certainly include the use of Artificial Intelligence, theory and technique, aided in time by the still embryonic field of artificial emotion, to simulate complex mental operations. This modelling system will be joined to an already swiftly maturing neurobiology of the brain, including the high-resolution scanning of computational networks active in various forms of thought. Important advances are also deemed to come eventually from the molecular biology of the learning process.

How does natural selection anticipate our future needs? Well, by creating a cognitive machine called brain that can create models of the world, and even of itself, and process hypotheticals much like a Universal Turing Machine can mimic any other Turing machine, and just like any given computer can run any program. This plasticity provides for its universal versatility (cf. Martin Davis, 2000).

It is useful to consider a duality I designate “Turing versus Eve”. The mathematician Alan Turing represents the computer in the essence of its complete flexibility. The Universal Turing Machine is the one which can imitate every computer, it is mimetism *par excellence.* That mimetism makes us think about the meme and our own mental flexibility, so vital in complementing genetic reproduction, due to the different

reproduction timings. In the latter, the difference spans across generations, and that is not enough when adaptation must be agile. It is from that need that stems the cerebral mechanism of reproduction – those memes which jump from brain to brain. In genetic reproduction, mitochondria are genetic structures from the feminine side which are replicated without mating of genes. They correspond to the specific modules we inherit in virtue of our species' past.

With this background in mind, and namely the discussion about specialized modules and general intelligence, I would like introduce at this point the informal notion of *cognome*, by analogy with genome, standing for an individual's particular structural combination of cognitive memes.

When considering scientific knowledge, if the computer processing of the human genome is what leads us to Bio-informatics then, by analogy, we may state that the cognome will be the basis of a future «Cognotechnology», applicable in any science. This way, the future of AI is connected to the characteristic of it being an epistemological instrument, not only for an autonomous agent, but a symbiotic one which will help humans in performing science itself.

And I'm not just talking about data mining, pattern recognition, ontology building, although in those fields we can approach more structured aspects of epistemology. I'm thinking about that which every scientist does, which is to abduce, invent and prophesy theories, put them to the test, create experiments, draw conclusions to support additional observations, discuss those observations and his conjectures with other scientists.

There is an ongoing meta-argumentation about what is good reasoning, what are the conclusions we can draw from a discussion (i.e. a semantics), which is inherent to all scientific activity. The computer will be used more and more as a research aide, not just to automate but also propose experiences and hypotheses and, in the end, by making our own conceptions on epistemology application repeatable and externalized, it will make them more objective too.

Veritably, the capacity for cognition is what allows us to anticipate the future, to pre-adapt and imagine scenarios of possible evolutions – of the world and of ourselves as cognitive agents – to make choices, to use preferences about some hypothetical worlds and their futures, and meta-preferences – preferences on which preferences to employ and how to make them evolve.

The activity of prospecting the future is vital and characteristic of our species and its capacity to understand the real world and ourselves, living in society, where distributed cognition is the normal and regular way to do science.

Prospective consciousness allows us to pre adapt to what will happen. For that, a capacity to simulate, to imagine "what would happen if", i.e. is hypothetical thinking, becomes necessary. Such thinking is indispensable in science; for it gives us the rules to predict and explain what will or can happen, without which technology would not be possible.

Lately, I've been working towards automating this capacity, by implementing programs which can imagine their futures, making informed choices about them, and then modify

themselves to enact those choices – the inklings of free will. We call it prospective computing (Luís Moniz Pereira and Gonçalo Lopes, 2009).

Epistemology will eventually have the ability to be shared, be it with robots, aliens or any other entity who must needs perform cognition to go on existing and program its future. Creating situated computers and robots means carrying out our own cognitive evolution by new means. With the virtue of engendering symbiotic, co-evolving, and self-accelerating loops. Computerized robots reify our scientific theories, making them objective, repeatable, and part of a commonly constructed extended reality, built upon multi-disciplinary unified science.

Artificial Intelligence and the Cognitive Sciences, by building such entities, provide a huge and stimulating step towards furthering Science Unity, through the very effort of that construction. To this end, the functionalist stance is most helpful.

9. Coda

Evolution, including genetic progress in human nature and human capacity, will be from now on increasingly the domain of science and technology, tempered by ethics and political choice.

With rare exceptions, universities have dissolved their curriculum into slurries of minor disciplines and specialized courses. A balanced perspective cannot be acquired by studying disciplines in pieces, but through the pursuit of consilience among them. Only fluency across the boundaries will provide a clear view of the world as it really is, not as seen through the lenses of ideologies and religious dogmas, or commanded by myopic response to immediate need.

Moreover, interdisciplinary high level research and communication channels need to be institutionalized, such as in Institutes of Advanced Study.

Last but not least, according to Edward O. Wilson (1998), gene-cultural evolution is the underlying process by which the brain evolved and the arts originated. It is the conceivable means most consistent with the joint findings of the brain sciences, psychology, and evolutionary biology. Still, *direct* evidence with reference to the arts is slender. It is possible that new discoveries concerning the brain and evolution will yet change the picture fundamentally. The uncertainty makes the search for the alignment of science and the humanities all the more interesting a prospect.

References

David M. Buss, editor (2005), *The Handbook of Evolutionary Psychology*, New Jersey: John Wiley & Sons Inc., 2005.

William S. Cooper (2001), *The Evolution of Reason: Logic as a Branch of Biology*, Cambridge Studies in Philosophy & Biology, Cambridge University Press, 2001.

Martin Davis (2000), *The Universal Computer: The Road from Leibniz to Turing*,

W.W. Norton & Co. 2000.

Paul R. Gross, Norman Levitt (1994), *Higher Superstition*,
The Johns Hopkins University Press, 1994.

John Holland (1998), *Emergence – From Chaos to Order*,
Reading: Addison-Wesley, 1998.

Steven Mithen (1996), *The Prehistory of Mind*,
London: Thames and Hudson Ltd., 1996.

Thomas Nagel (1997), *The Last Word*, Oxford University Press, 1997.

Luís Moniz Pereira, Gonçalo Lopes (2009). *Prospective Logic Agent*s, International Journal of Reasoning-based Intelligent Systems (IJRIS), 1(3/4):200-208, 2009.

Nicholas Rescher (2005), *Realism and Pragmatic Epistemology*,
University of Pittsburgh Press, 2005.

Stephen Shennan (2002), *Genes, Memes and Human History – Darwinian Archaeology and Cultural Evolution*, London: Thames & Hudson Ltd., 2002.

Charles Sherrington (1941), *Man on His Nature*,
The Gifford Lectures, Edinburgh 1937-8; New York: Macmillan, 1941.

Edward O. Wilson (1998), *Consilience – The Unity of Knowledge*,
New York: Alfred A. Knopf, 1998.