

# **MODULES FOR ALL SEASONS? DOMAIN-SPECIFICITY, ECOLOGICAL PLASTICITY AND CULTURE**

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## **Abstract**

A theoretical divide exists on the study of the adapted psychological mechanisms underlying human culture. It has been said for instance that we evolved a brain for all seasons (William Calvin) and that this is opposed to the framework of the modularity of mind (Kim Sterelny or David Buller, inter alia). We approach the nature of these explanatory differences based on what we judge to be a misunderstanding with respect to the evolution of domain-specific modules. We underline the fact that the input-domain of a module and its ecological function should not be conflated. We propose a more generous way of considering how evolutionary functions in mental architecture account for the possibility of general adaptations for cultural cognition. We show that modularity happens to be a good tool to research and decompose mechanisms with plastic functions such as in some forms of social learning. The idea of “modules for all seasons” is so vindicated.

**KEY WORDS:** Modularity; Ecological plasticity; Domain-specificity; Culture; Mental architecture

## **Resumen**

Existe una divisoria teórica en el estudio de los mecanismos psicológicos biológicamente adaptados que subyacen a la cultura humana. Se ha dicho, por un lado, que hemos evolucionado un cerebro para todas las estaciones (William Calvin), lo que se opone, por el otro, al marco de la modularidad de la mente (Kim Sterelny o David Buller, entre otros). Consideramos la naturaleza de estas diferencias explicativas sobre la base de lo que nos parece un error de comprensión acerca de la evolución de módulos específicos de dominio. Subrayamos el hecho de que el dominio de entrada de un módulo y su función ecológica no deben ser confundidos. Proponemos una manera más generosa de considerar cómo las funciones evolutivas de la arquitectura mental pueden dar cuenta de la posibilidad de adaptaciones generales a la cognición cultural. Mostramos que la modularidad resulta ser un buen instrumento para investigar y descomponer mecanismos con funciones plásticas, como las que encontramos en algunas formas de aprendizaje social. De este modo, se defiende la idea de “módulos para todas las estaciones”.

**PALABRAS CLAVE:** Modularidad; Plasticidad ecológica; Especificidad de dominio; Cultura; Arquitectura mental

## 1. Against the “one major new adaptation” explanations... with a “but”

In the third chapter of *The Architecture of the Mind*, Peter Carruthers confronts the idea that the transition from non-human minds to human minds may be the result of “one” (or just a few) very special events in the genetic and cognitive dimension. According to this idea, dubbed “the one major new adaptation hypothesis”, the flexibility and capacities to generate culture is parsimoniously explained with reference to a single evolutionary event, an adaptation in terms of language, or mind-reading, or imitation, or even just an increase in so called “general learning” abilities or encephalization. Carruthers argues against this general pattern of explanation on the argument that these “one major new adaptation” models are unable to account plausibly for other distinctively human capacities (i.e: universals). Carruthers goes on to propose a non-exhaustive list of more than twenty of such capacities, including folk-physics, mind-reading, language faculty, sophisticated imitation abilities, and other capacities such as those related with the mastery of social norms, motivational components or a sense of humor (see Carruthers, 2006, pp. 155-6) (note that these are not necessarily proposed as “biological adaptations”).

From this starting point we want to comment on what we consider to be two different points here:

**1st. point:** Carruthers is totally right in pointing the weaknesses and inconsistencies of evolutionary “saltationist”<sup>1</sup> hypotheses constructed according to the “one major new adaptation” pattern. We believe that it is indeed the case that there is something flawed in arguments such as those of the paleoanthropologist Richard Klein about the “big bang” of human culture (Klein, 2003) as being caused as recently as the Upper Paleolithic by a unique and special genetic mutation with brain effects; or that of the primatologist Michael Tomasello defending that there was “a small difference that made a big difference” (Tomasello et al., 2005, p.690), which he identifies with imitative capacities, and that caused the cognitive dissimilarities between great apes and humans. These arguments rest on a weak inductive as well as deductive basis. We endorse Carruthers’ side on this point.

**2nd point:** Although it is plausibly the case that the evolution of human cognition is more gradualist and multifactorial in character than

<sup>1</sup> Admittedly, the idea of “saltationism” in the evolution of cognition and the idea of the “one major new adaptation” do not imply each other necessarily from a logical point of view. Nevertheless, as it is usually presented, the “one major new adaptation” pattern of explanation is, almost invariably, saltationist in character.

the proposed saltationist models, it may still be true that human cultural cognition, arguably the most impressive trait of human evolution, is not equally well explained by reference to the twenty-two capacities proposed by Carruthers. In other words, it may still be true that the human basic cultural cognition tool-kit evolved through the selection of a very particular class of inborn adaptations, even if by now cultural transmission relies on a plurality of mechanisms such as, among others, the universals proposed by Carruthers.

In this paper we want to elaborate on the apparent chasm between statements 1 and 2 and on the reasons why in the present debate if you affirm point 1, you are expected to deny point 2 or vice versa. In so doing we aim to advance a perennial disagreement between certain domain-specific and certain domain-general views of the evolved mind, that we denounce as being sometimes based on a mutual misunderstanding or confusion on the meaning of terms such as “domain-specificity” or “modular”. We do this in order to better introduce our idea of domain-specific modules that are also ecological polymaths: modules for all seasons. We will argue that such a notion of module is a useful tool to account for plastic functions such as those of our evolved capacities for exploiting cultural information.

## **2. The “big mistake” and “big success” patterns of explanation with respect to human evolved cultural capacities**

The theoretical divide we want to address here is that between what anthropologists Rob Boyd and Peter Richerson (Richerson & Boyd, 2005) have called the “big mistake hypothesis” of the evolution of human culture, face to face to what, in a parallel denomination, we may call the “big success hypothesis”. It is important to note that the terms “mistake” and “success” should not be understood as referring to a pejorative or value-laden dimension, but rather as denoting different emphases on related aspects of the explanatory schema. Let us contrast the nature of these different approaches:

The “big mistake hypothesis” as a pattern of explanation for the phenomenon of human culture has been most thoroughly defended by proponents of evolutionary psychology: what’s called the “adapted mind” paradigm<sup>2</sup> (see specially Barkow, Cosmides & Tooby, 1992). The basic idea at work in this explanatory schema is that, for the most part, the

<sup>2</sup> It is, of course, possible that they would not recognize themselves under such an apparently value-laden label- but that is another matter.

information necessary to produce human culture is to be found in genes shaped by Pleistocene pre-cultural<sup>3</sup> environments. Thus, human culture is researched as mostly the result of decision-making mechanisms shared with our ancestors in Pleistocene environments. On this view, culture is mainly the result of the interaction of the Pleistocene mind with that changing environment. The “mistake” means then that our minds are not always adapted to different aspects of the rapidly changing Holocene environments and thus little present behavior is to be predicted by reference to adaptive dynamics. Of course, the degree by which cultural behavior is to be considered as “evoked” (Cosmides & Tooby, 1992) by ancient genes and decision-making systems is a matter of degree which varies among different theorists. Still on the “big mistake” camp you can find what in the evolutionary psychological framework is called “epidemiological approaches”. Culture as an epidemiological phenomenon emphasizes the dimension of social transmission. But methodologically it relies nonetheless on the question of the relative ease of transmission of cultural elements. The epidemiological approach is thus founded on the fact that agents must psychologically reconstruct many elements of the cultural chain of transmission (Sperber, 2006). It is a model that owes much to the host-pathogen model of disease transmission, in that cultural elements exploit input systems of the evolved mind, but, and this is the essential point, these input systems are for the most part (and “for the most part” is an important qualification) not naturally designed for cultural transmission themselves.

On the other hand, proponents of the “big success” pattern of explanation, rely on the dynamics of cultural transmission. Cultural transmission is understood here as depending more upon “culture-specific” adaptations in the domain of social learning. Under this account, these mechanisms of cultural transmission would be direct adaptations to the challenges posed by, arguably, a rapidly changing Pleistocene environment. On the famous account of Boyd and Richerson’s classical studies on the adaptiveness of social learning, social learning is seen as an adaptive response of individuals in a population when the environment changes fast enough so as to close the door to the evolution of genetic responses (natural selection takes generations), but not too fast so that it is profitable to rely on the experience of others, since their solutions may still apply to the ecological problems (see Boyd & Richerson,

<sup>3</sup> Or at least, pre- “modern human culture” in the sense that paleoanthropologists give to the adjective “modern”, here meaning pre-late Pleistocene.

1988). On this view, culture would be a specific response to this general type of adaptive dynamics, or to put it again in Boyd and Richerson's words, an adaptability device "built for speed" (Richerson & Boyd, 1999).

Concerning the differences between the "big mistake" and "big success" positions, note that both should be construed more as points in a continuum, rather than as a necessary one-or-the-other affair. Thus, our intention is definitely neither to create another false dichotomy<sup>4</sup> nor a strawman. We would rather like to underline the fact that different emphases have been given to the study of the evolved capacities underlying human cultural cognition and that these emphases have turned into different approaches. Unfortunately, since the theoretical controversy surrounding the issue of the evolution of human cognition has been hot and passionate, the positions have often become polarized. We think that this differential emphasis, if carried to the extreme, may partially explain two opposite movements: why a good number of philosophers, reacting against what was perceived as a (perhaps even dangerous) explanatory bias, have published essays against the fundamentals of "evolutionary psychology". And how researchers working within the standard evolutionary psychological framework have also often reacted against "plasticity" views of cultural cognition, caricaturing them as attributing supernatural powers to human nature.

**Examples of studies that into use the by-product, or "big mistake" explanatory pattern of cultural cognition**

Sperber, D. & Hirschfeld, L. (2003) "The cognitive foundations of cultural stability and diversity"

Nichols, S. (2002) "On the genealogy of norms: A case for the role of emotion in cultural evolution"

Lieberman, D., Tooby, J. Cosmides, L. (2003) "Does morality have a biological basis? An empirical test of the factors governing moral sentiments relative to incest"

**Examples of studies that put into use the culture-specific, or "big success" explanatory pattern of cultural cognition**

Fessler, D. T. (2006) "Steps towards an Evolutionary psychology of a culture-dependent species"

R. Boyd & P. J. Richerson, (1995) "Why Does Culture Increase Human Adaptability?"

P. J. Richerson, R. Boyd, & J. Henrich. (2003) "The Cultural Evolution of Human Cooperation"

<sup>4</sup> See Fessler(2006), for a similar presentation of the state of the art in evolutionary cultural cognition studies.

**Examples of studies that into use the by-product, or “big mistake” explanatory pattern of cultural cognition**

Fessler, D. M. and Navarrete (2003), “Meat is good to taboo Dietary proscriptions as a product of the interaction of psychological mechanisms and social processes”

Kelly, D. (in prep.) “Moral disgust and Tribal Instincts A Byproduct Hypothesis”

Atran, S. (2006) “Religion’s Innate Origin and Evolutionary Ground”

**Examples of studies that put into use the culture-specific, or “big success” explanatory pattern of cultural cognition**

R. McElreath, R. Boyd & P. J. Richerson. (2000) “Shared Norms Can Lead to the Evolution of Ethnic Markers”

Henrich, Joseph and Robert Boyd (1998). “The evolution of conformist transmission and between-group differences”

David Sloan Wilson (2002), *Darwin’s Cathedral*, Cambridge University Press

This polarization may turn out to be positive in some respects, such as for instance in that it promotes a healthy division of labor between a psychologically oriented approach and a cultural-anthropological approach on the other. Nevertheless we will argue in the following sections that this divide is sometimes grounded on a flawed view of modularity and the domain-specificity of human cognitive adaptations. And in that respect we may not be “carving nature at its joints”.

**3. General-purpose mechanisms, the blank slate and other myths. But should we throw the baby with the bath water?**

From Renaissance humanists, European existentialists, German idealists, and Marxists to behaviorists and postmodernist constructivists, many have reasoned that the human species may have no specific or “inborn” nature. For the most part of the twentieth century, even the so-called Standard Social Science Model relied upon an intrinsically plastic view of human nature, consisting just on very general-purpose capacities such as associative learning and memory that could indefinitely be modeled by culture. The denial of a biologically evolved human nature by the modern myth of the blank slate has been famously denounced by evolutionary psychologists (Pinker, 2002). These

evolutionary psychologists are right, by our lights, in affirming the scientific incoherence of an all plastic, general-purpose problem-solving mechanism which simply could not have evolved by natural selection and would place us too radically apart from the rest of the animal kingdom. Nevertheless, apart from this anti-biological “wishful thinking” of an all-plastic human nature, it is also a biological fact that humans as a species have indeed colonized the most separate geographic habitats and that in so doing their patterns of behavior have been shown to be immensely variable in comparison to any other species on Earth. The power of the human species to colonize the planet, including remote islands and polar and tropical latitudes is a prehistorical fact, taking place in late Pleistocene, and is related to the cultural intensification that plausibly took place some time before the Upper Paleolithic or Later Stone Age. Certainly, the scientific explanation of this cultural empowering of the human species should not be given in terms of the quasi-miraculous gift of an all-plastic mind. But the question then arises as to what extent is the enterprise of evolutionary psychology - conceived as the quest for modular, domain-specific mechanisms in our evolved mind- is able to satisfy our thirst of explanation for an empowered and diverse human mind, with cultural capacities that appear in many respects as general purpose, and under some accounts, “non-modular”.

We argue that in its explicit attack to the Standard Social Science Model in which humans are empowered with an all-general capacity for learning, evolutionary psychologists may have thrown the baby with the bath water. They would have done this by neglecting or even closing the doors to any evolutionary explanation of general-purpose psychological mechanisms designed to cope with cultural transmission. But this may be seen as an unhappy historical accident, derived from some too coarse arguments against the prevailing standard social science model, which yield a narrow and problematic understanding of the research programme of Evolutionary Psychology. From this point of view, we see as a useful task to show that a massively modular brain is also plausibly a “brain for all seasons” and vice versa.

#### **4. What modularity is not (anymore)**

We think that one of the reasons both for a very extended prejudice against evolutionary psychology, and for evolutionary psychologists’ premature refuse of investigating general mechanisms of cultural transmission, may rest on a confusion on what modularity is and on what the modular view of the mind commits one to.

Although the modularity of mind was first popularized in the writings of Jerry Fodor, the users of this notion today (basically evolutionary minded psychologists, comparative psychologists and neuroscientists) employ more simplified notions of modularity that do not coincide with the Fodorian view of modules.<sup>5</sup> A Fodor-module, we remember, was a domain-specific innately specified processing system, with its own proprietary transducers, delivering ‘shallow’ (non-conceptual) outputs, mandatory in its operations, swift in its processing, isolated from and inaccessible to, the rest of cognition, associated with particular neural structures, liable to specific and characteristic patterns of breakdown, and developing according to a paced and distinctively arranged sequence of growth (Fodor, 1983). On the contrary, in most recent notions of modularity (Pinker, 1997; Sperber, 2005; Barrett 2006, Barrett & Kurzban, 2006; Buss, 2005), modules are theoretical terms defined by the specific operations that individual modules perform or the information they receive, and not by a list of general necessary and sufficient conditions. The modules are also correctly described as cognitive biases that make brain systems attend to some stimuli rather than others and to do it in specific fashions. In order to save the concept of module from trivialization (that is, the risk that modules become just boxes in diagrams representing the flow of information with no commitment whatsoever to its actual implementation in the brain), cognitive modules should also be considered as a subclass of biological modules, distinguishable not just functionally but also neurologically,<sup>6</sup> and with a particular history of development in the individual brain (see Sperber, 2005).

Thus, to sum up, since its introduction in the philosophical debate by Fodor, the concept has moved from a highly demanding, highly constrained characterization to a more operative and inclusive general idea of functional distinction and differentiation of mental components. In what can be seen as a progressive relaxation of the conditions of a system to be considered as modular, functional and neurological individuation (doing different things and being implemented in at least partially different biological structures) and domain-specificity have remained central features. In addition, these modular, dissociable systems can be seen as inborn or genetically channeled, or, on the contrary as constructed or acquired via (probably modular) learning processes

<sup>5</sup> In this sense, the modularity framework is a perfectly normal case of conceptual progress in which theoretical terms may overcome their creator’s design.

<sup>6</sup> Of course, it does not imply any strong claim as to the physical location of modules in discrete clusters, such as in the bad old days of phrenology.



(Carruthers, 2006, p. 62). As for the property of being a genetic adaptation or an acquired module, the properties of encapsulation, inaccessibility and so on may be specific to the given module, but not to be stipulated a priori.

## 5. Two arguments and two readings of domain-specificity

Domain-specificity is naturally linked with functional individuation, but its very idea as it is sometimes defined is confusing. A less problematic definition of the specificity of a cognitive domain is its “formal” definition (see Barret & Kurzban, 2006). The formal definition of a domain is the set of inputs, as specified by algorithmic rules, that a given cognitive system may operate with. This set of inputs is thus to be specified by certain informational properties that the brain system in question could select and operate with. The fact that this set of inputs is restricted by a formal description of its constituents is, simply, what gives the domain its “specific” character.

Classically, the prevalence of domain-specificity for modular systems has been argued on the basis of two very general arguments: one turns on computability or tractability, the other on evolvability. While the first is a firm descendant of the AI cognitivist tradition, the second is a descendant of the Neo-Darwinian framework typical of more recent approaches in Cognitive Science.

**First:** The argument from computability. Domain-specificity has been defended as a design feature of the mind because of its superior (faster, more efficient, etc.) performance in problem solving. Thus Scott Atran writes, “These modular faculties automatically (innately and through maturation) parse the flux of human experience into manageable proportions. Otherwise, the world would seem too noisy for humans to acquire such rich and complex systems of knowledge in fairly unique and uniform ways (hence not susceptible to modeling by associationist processes, connectionist or otherwise), despite wide individual variation in exposure to diverse and fragmentary experiences” (Atran, 2002). This argument states that combinatorial explosion paralyzes any system that is truly domain-general, since it must face the problem of deciding on the relevance of the available information, and in truly domain-general systems the possible range of relevant information is computationally intractable. That is one of the morals of the cognitive revolution that took place in the 60s in the study of perception and language abilities. It was then recognized that the number of possible interpretations of the stimuli that a learning individual receives greatly exceeds her general learning capacity, thus leaving her helpless with the problem of both perceptually

orienting herself in the world or acquiring language. Domain-specificity, by parsing the world into meaningful information is already part of the answer to that vicious combinatorial explosion. (But see Paco Calvo on this volume for an alternative approach)

**Second:** The argument from evolvability. This is sometimes presented as a sort of evolutionary extension of the argument from computability. Since an informationally specialized mechanism is likely to perform more efficiently than a system with a generalist functioning, it may be expected that natural selection has favored cognitive systems with domain-specific modules. This argument, once connected with the general observation that nature favors organisms with different modular parts (lungs, heart, wing, etc.), that solve different specific functions (respiration, blood circulation, fly, etc.), leads standard evolutionary psychology to the typical evolvability argument for domain-specificity. Thus, Cosmides and Tooby have expressed the evolvability argument in the following terms: “What counts as fit behavior differs from domain to domain, so there is no domain-general criterion of success or failure that correlates with fitness /.../ these could not have produced fit behavior under Pleistocene conditions (and therefore could not have been selected for) unless they were embedded in a constellation of specialized mechanisms that have domain-specific procedures, or operate over domain specific representations.” And Cosmides & Tooby go to conclude “domain-specific cognitive mechanisms /.../ can be expected to systematically outperform (and hence preclude or replace) more general mechanisms” (Cosmides & Tooby, 1994, p. 89)

It appears that if you start at Darwinism, you end up by necessity with domain-specificity: on the one hand, it seems that natural selection will favor mechanisms with a well specified functioning that can incorporate some sort of a priori information (no matter how specific) about the problem to be solved and thus avoiding combinatorial explosion; on the other hand, specific devices will be tightly meshed with the environmental conditions that shaped their evolution. That is to say, concerning cognitive devices only specific problem solvers, not general problem solvers, can evolve, because organisms face specific problems. Accordingly, the domain of a given modular system should reliably reflect the structure of the specific adaptive problem our ancestors faced. But there is clearly a problem here in the evolvability argument in that there are two different aspects that should be cautiously separated. These two aspects correspond to two different readings of the word “domain” in the theoretical foundation of evolutionary psychology.

1. Domains can be conceptualized as input-domains i.e. the set of formally specified inputs
2. Alternatively they can be viewed as cognitive domains, which we would rather call “ecological domains” and that refer to selective pressures in evolutionary environments.

These two meanings, we think, are conflated in the previous Cosmides & Tooby’s quote. This second reading of domains can be seen still more clearly in passages such as the following (extracted from a relevant article on domain-specificity in the Primer on Evolutionary Psychology of the University of Santa Barbara): “Domain specificity means that adaptations evolve to solve problems in particular domains, and therefore are less well suited to solve problems in other domains. A domain is a selection pressure or (equivalently) a reproductive problem.”<sup>7</sup>

It seems to us that an unjustified transposition has been made here between the (correct) premises of the computability argument and the (incorrect) conclusion of the evolvability argument. Input-domains and ecological-domains have thus often been conflated and domains have (we think wrongly) been identified with selection pressures. You can read the identification of domains with adaptive problems or selection pressures in statements such as the following: “A domain, when referring to a psychological mechanism, is a selection pressure, an adaptive problem. Domain then is synonymous with problem. A domain-specific mechanism refers to a problem-specific mechanism – a mechanism that evolved to solve a specific adaptive problem.” (Atkinson and Wheeler, 2004 p. 150). Or still, “what do evolutionary psychologists mean when they refer to a domain? If our cognitive resources are supposed to be ‘specialized for solving evolutionary long-enduring adaptive problems’ (Tooby & Cosmides, 1992, p. 34), then it seems that adaptive problems are the phenomena with respect to which those resources are (putatively) specific” (Krill et al., 2007)

Thus it appears that at least two different notions of “domain” have confusedly<sup>8</sup> circulated in the discussion of the issue of what modularity

<sup>7</sup> <http://www.psych.ucsb.edu/research/cep/primer.html>

<sup>8</sup> The most charitable interpretation we can give of this plurality of meanings is that there are different concepts of module and domain at hand in these debates and the extent to which these concepts may or may not be identical is an empirical case-by-case question that we could interpret in a similar flavor with other epistemological questions such as to what extent do the different concepts of genes or biological species coincide with each other

is and how modular our minds are. “Domain” may refer to 1) the formally specified set of inputs that a given cognitive system is dedicated to process. Or it may refer to 2) the ecological problem it is naturally designed to cope with. This difference is not without consequences. In particular, standard evolutionary psychologists seem to have committed themselves to a view of the evolution of human cognition that precludes or neglects the study of generalist cognitive devices that are denounced as “domain general” in a broad sense and thus unable to evolve. A central aim of this paper is precisely to show that generalist cognitive devices may indeed be studied under the framework of evolved modularity, i.e. under the idea of “modules for all seasons”.

## **6. Domain specificity and function specificity should not be conflated**

Input-domains defined as the set of formally specified inputs, should not be regarded as identical with adaptive problems. Controversy has thus arisen because evolutionary-minded psychologists have often used the term to refer to particular “domains” of behavioral ecology, such as the mating domain, the eating domain, the communication domain, etc. These are views of domains as biological activities. We will call these types of domain “ecological domains”, without going much deeper in conceptual analysis. What is most important to note for our present purposes is that every time criticism has arisen in order to show that one given mental mechanism applied to several of these domains, this has been advanced as an evidence of domain-generality. This is unnecessarily confusing, since the specificity of the ecological use of the mechanism says nothing of its specificity in terms of information processing and types of inputs.

It is a well-argued point advanced by proponents of evolutionary psychology that a view of evolved function informs hypotheses about input-types. Systems that solve different functional problems will arguably deal with specific input sets. Thus, ecological-domains are sometimes helpful criteria to delineate the input-domains. Cognitive systems dedicated to food choice will process representations relevant to nutritional value of potential food, systems dedicated to mating will process cues relative to relevant information on fertility values, etc. Even more concretely, input-domains can be discerned by using the tripartite conceptual framework for analyzing information-processing systems that Marr (1983) popularized in his account of vision. If we want to have a formal description of the domain of the module, the aim then is to specify

the algorithmic level. This level is constituted by the possible algorithm that the system in question may put into use when resolving a specific task and comes along with descriptions of the type of representations required as input and output for the system to work efficiently. One level under, you find the hardware level, which refers to the particular implementation or material substrate of the mechanism in question. On biological cognitive systems this corresponds to the specific parts and activities of the brain. On the top of both these levels you can find the computational level (although we may prefer to call it the “ecological level” following Kim Sterelny’s usage (Sterelny, 1990). This level refers to what the system does in its background context and thus also to the broader meaningful effects of this systems in its environment. Knowledge of each level is useful for the enterprise of individuating a given domain.

But still, these levels are different and to equate the narrowness of the domain-input with the broadness of the ecological domain would be a sort of category mistake. A technological analogy may be of use here: take the simple case of a spellchecking device in your favorite word processor. As you use one of these useful computer programs, you are applying a well-defined algorithm to a whole range of different characters, carrying different contents and meanings and applying to different aspects of life. Nevertheless the input domain of the program is well specified, namely chains of characters of a given alphabet. And so happens to be its function, namely spellchecking. Or again take the case of a search-engine as a tool for navigating the Internet. Its domain is vast as it extends to the whole accessible World Wide Web, but its search algorithms precisely characterize it. Note again that the formal specification of this search algorithm may orient it towards very specific syntactical cues. Nevertheless, these syntactical cues may create links that cover extensive (in principle unlimited) semantic domains and that once put into use may have multiple functions. And thus you can put into use the “domain-specific” favorite search engine for such different activities such as finding a list of publications of Peter Carruthers, getting a blind date or looking for a restaurant in Palma.

Most importantly, the fact that functions can be attributed at various levels makes ambiguous the evolutionary psychologist’s statement that one evolutionary problem equals one domain. Before stepping into cognition, consider some more pedestrian examples. Thus take precisely the study of the evolution of locomotion in a given species as an instance. Locomotion can be studied by reference to an “ecological domain” and thus it could eventually be related to food searching, escaping from predators, habitat-changing, or optimizing mate choice. These

functional hypotheses can eventually be true or false, but permitting the given species to move in a certain fashion (as researched by biomechanicists) is nonetheless a more immediate proximate function of locomotion. Or take the case of the beaver's dam. Manifestly the proximate function of the beaver dam is holding up water or even, on some accounts, reducing the noise of moving water. On the other hand, more remote functions of beaver dams may be to serve as a protection against predators, such as coyotes, wolves and bears, or to provide easy access to food during winter, or even both at the same time. We would like to oppose the term "proximate function" to a more general notion of ecological utility, use, or "remote function" in the same sense in which, for instance, the United States Patent and Trademark Office establishes a distinction (when it comes to forms of classifying) between use (or industry) and proximate function. In other words, the proximate function is the basic function on which the successful performance of other higher-level functions depends. It should be clear by now that there is not a one-to-one specification of the remote function by the proximate function.

Take now a cognitive example. Consider for instance the language faculty, whose proximate function is arguably to permit the acquisition of a language (Sperber & Origgi, 2000). A more remote function of the language faculty may be to promote communication. Even more remote functions of the language faculty may still be benefiting from cultural knowledge, elaborating complex forms of coordinated action, telling jokes, deceiving and manipulating others, seducing possible mates, maintaining social bonds: all of these possible remote functions of language have no doubt fitness consequences. The language faculty may thus be a good example of what we will present in the final section as a possible "module for all seasons." It is clear enough (or at least it has been the strong point of cognitive psychology since Chomsky's work in the 60s) that the language capacity is not the result of a domain-general faculty in the sense in which (to give the simplest version of the debate) Skinner wanted it to be in his theory of "verbal behaviour" based on associative mechanisms and memory. Hence, although it may have evolved to solve the problem of acquiring linguistic abilities, it could still be the case that several of the aforementioned fitness considerations applied to the language faculty during its evolution. However, it could not be said that the language faculty was the specific solution to a specific problem pre-existing it, but rather that if there is a multi-function capacity of the human psyche, a multi-purpose gadget on which to rely for a variety of purposes, then that is indeed language. Thus, by instantiating its proper function, the language faculty could be in every specific occasion performing very

different derived functions that could have some specific remote adaptive value in each situation but which, broadly considered, could be described as the solutions to a very general problem (if this “problem-solution” way of speaking is still to be considered of any use<sup>9</sup>).

## **7. Arguments against a too narrow functional specification of modules**

Input-domains and ecological domains are thus different concepts. We have seen that “input-domain” is a relatively simple notion related to actual functioning, whereas “ecological domain” is a notion that hides the complexity and multi-level nature of what a part of a biological system does in its environment. It is an empirical matter to say whether input-domains do or do not always relate to a very specific ecological function. It need not be so. In the following sections, we put together three arguments in favor of a clearer distinction between input-domains and evolved functions:

1. The grain problem or the difficulty of specifying adaptive problems.
2. Machiavellian cognition and the hostile nature of human environments in evolution.
3. The “curb cuts” principle and the importance of developmental plasticity in evolution as the key to domain-specific but function-general systems.

### *1. The grain problem in specifying the ecological domain of modules*

The first one is an epistemological argument. The so-called grain problem in adaptationist considerations serves as a cautionary tale for the enterprise of searching to delineate domains by reference to adaptive problems or selective pressures. It refers to the difficult task of individuating evolutionary challenges (Sterelny & Griffiths, 1999; Griffiths, 2002; Atkinson & Wheeler, 2004; Barrett, 2006). The question is that if we are to individuate domains by reference to evolutionary challenges, we should conceive of them in specific terms. Thus, if the mind

<sup>9</sup> Evolutionary biologist Richard Lewontin famously criticized the view of adaptive evolution as a “lock-and-key” phenomenon: the environment poses specific problems and the organism responds adapting to them. This was exactly the view of the evolvability argument offered by Cosmides and Tooby and their followers in defending a particular view of “domain-specificity” as the response to specialized selection pressures.

is to be considered as a collection of special-purpose modules adapted to solve not general but concrete problems, we should be in a position to characterize these evolutionary problems at the appropriate level or “grain”. But what are the problems that exist “out there” in the environment? Every time we choose a level of description for an ecological problem, we may in principle decompose it into lower-level “finer-grained” ecological problems. For instance, it could be argued that a module should serve the function of mate-choice, but it could as well be argued that there should be a multiplicity of modules subserving more lower-level related problems, such as assessing the partner’s fertility, assessing infidelity risks, evaluating the partner’s quality in helping, offspring care, etc. And how can one specify the exact number of selective problems there are? This is especially important if we insist (as some evolutionary psychologists do) in defining the module in terms of an ecological domain (not an input domain). As Atkinson & Wheeler (2004) write: “If the specification of selection pressures is ultimately relative to the level at which we describe the evolutionary scenario, then so is what counts as a domain” (p. 161). This context-dependency is, to say the least, unsatisfying. Certainly it is not dead easy to know when our hypothesized module corresponds to a single task problem with numerous associated ecological functions, or rather to a plurality of tasks each subserved by a plurality of modules so that each constitutes a specific solution to a specific selective aspect. The a priori specification of the selective problems of an environment is a desperate quest since the number of potential niches of an external environment is infinite. It is not possible to take a region of spacetime, an external environment, and determine how many “problems” it contains. These problems will be potentially overlapping and their existence will depend in fact on the evolution of the given population. Thus, selective problems are co-determined by the nature of the population and its ecological niche. The moral of the story is, to put it in the words of the philosopher Paul Griffiths, that “problems whose solution cannot be developmentally dissociated must be solved as a single problem and so are not separate problems from the standpoint of adaptive evolution” (Griffiths 2002, p. 13).

This apparently metaphysical disquisition has important implications for simple research cases, as can be the case of specification of the proper domain of a hypothesized module. Take the well-known case of the face-recognition module that manifestly would be instantiated in the fusiform gyrus and related areas. There has been a long-enduring controversy to determine whether the proper function of this cognitive system was to process face-like inputs or rather a more general function



such as discriminating between middle-sized objects of the same category on holistic cues. The truth is that it would be at least possible that we could not decide on this question “in principle”, since there is the possibility that, for instance, the only way our genome had to control the development of a cognitive system for discriminating faces was through the more general mechanism of discrimination proposed by detractors of the face-recognition hypothesis. More generally, we should always keep in mind this point of the pragmatism of the indeterminacy of the fine grain of selective problems.

## 2. *From Machiavellian selection pressures to plasticity*

The argument from Machiavellian selection pressures against the evolvability argument of evolutionary psychology is an attack to the idea that distinct modules evolved to solve very specialized recurrent problems in our environment of evolutionary adaptiveness. To build a function-specific module (in the one problem-one solution scenario of Cosmides and Tooby), the evolutionary problem or selection pressure must be stable over evolutionary time. In problems of the physical and inanimate world (such as vision or orientation) these conditions are easily met. As the philosopher Kim Sterelny has put it, “there is no arms race between our visual mechanisms and most of the physical world” (Sterelny, 2003, p. 186). Thus, some ecological problems such as vision call for a highly constrained functional specialization. On the other hand, there are hostile living environments: a very important part of the selection pressures faced by our ancestors in the Pleistocene were arguably social, such as the capacities required for a hominid to engage in group coalitions and survive and reproduce successfully in a highly demanding social environment. The Machiavellian intelligence hypothesis affirms that the special character of human cognition evolved as a response to the complexification of social environments and in particular to the growing complexity of social alliances and social exchange, with the ever present risk of deceit and defection. Thus hominids would have evolved fitter brains for social cooperation and competition via a spiraling arms race in which social competitors could develop increasingly sophisticated “Machiavellian” strategies (see Byrne & Whiten, 1997; Orbell et al., 2002). Under this assumption of Machiavellian intelligence, input-specific cues (such as those linked with cooperativeness and deceptiveness) may be useful in solving evolutionary problems that nevertheless we would rather qualify as general in the same sense that some animals are described as “generalists”: when the environment is rapidly changing highly specialized organisms are in

disadvantage to more flexible, less specialized ones. Our lineage became that of a “social generalist” animal just as much (or even more) as it became a dietary-generalist animal relying on very different sources of food. Hence, Machiavellian environments call for a different view of adaptations than just a lock-key pattern of specialization, even though it could still be the case that Machiavellian cognition is implemented by domain-specific modular systems perfectly well specified in their proximate (not ecological) functions.

### *3. The “curb cuts” principle and developmental plasticity as a force in evolution*

A curb cut, dropped kerb (U.K.) or pram ramp (Australia) is a ramp leading smoothly down from a sidewalk to the street, rather than abruptly ending with a curb dropping several inches. The “curb cuts” principle, as asserted by neurophysiologist William Calvin (Calvin, 2004) makes the point in the following way: consider curb cuts, originally intended for wheelchair users; their use has now been extended to rollerblades, skateboarding, people with strollers, bicycles, etc. It was the importance of facilitating the mobility of wheelchair users that initially paid for curb cuts, but it soon became evident that curb cuts are well designed for bicycle users, for strollers and other purposes, and, it may be said that all these purposes contribute now to the maintenance and diffusion of curb cuts in our cities. Though it was originally wheelchair users that motivated our local governments to install curb cuts, its evolutionary rationale is now much broader than this. The point is that much of our mental adaptations are presumably like curb cuts. What this metaphor means is simply that there exists a plausible way in which modules can become less function-specific and more function-general in phylogenetic time, while still retaining the properties of domain-specific systems. We find once more an idea contrary to the Tooby & Cosmides’ view, according to which relatively function-general capacities will be systematically outperformed by function-specific capacities.

In a similar vein, research on the role of developmental plasticity in hominid evolution compels a different prediction, as that of the evolvability claim of evolutionary psychologists. Developmental plasticity, the responsiveness of organisms to changes in their environments along their ontogenesis, is an ubiquitous fact in nature. Recently its importance as a factor in adaptive evolution has been vindicated (See West-Eberdhard, 2003). For our purposes here it’s enough to keep in mind that when mechanisms of developmental plasticity evolve in a species it

is not because they are suited to a very specific feature of the environment, but rather because they allow a variety of specific responses to the environment of the species. These mechanisms may be of the greatest importance both in ontogenetic and in phylogenetic terms (Jablonka & Lamb, 2005). This idea has been taken seriously by some anthropologists, such as Rick Potts or Boyd and Richerson (Potts, 1996; Richerson & Boyd, 2005), for whom the evolution of human cultural cognition is a special case of a more general mammalian trend for developmental plasticity. Recently, psychologists like Chiappe & MacDonald (2005) have criticized what they consider to be a narrow-minded view of adaptive evolution in the Cosmides and Tooby's research programme. Namely, they criticize the definition of adaptation advanced by Tooby & Cosmides because it implies the necessary recurrence of "environmental problems" which precludes the way for an adaptation to face novel problems. MacDonald & Chiappe offer a more realistic concept of adaptation by stating that "an adaptation is a system of inherited and reliably developing properties that became incorporated into the standard design of a species because it produced functional outcomes that contributed to propagation with sufficient frequency over evolutionary time" (p. 29). This "selective propagation with sufficient frequency" is not a concept that precludes a Darwinian view of organisms in selective environments. It is just that in the case of the evolution of mechanisms of phenotypic plasticity, these would sometimes not be appropriately described in "problem-specific" terms. Chiappe and MacDonald's response to Cosmides and Tooby is a psychology of domain-general devices. We, on the contrary, want to take sides with the idea of domain-specific mechanisms even if they evolved in response to "more general" problems. Functional plasticity and modularity are not like cat and dogs, not at all.

Let's see an illustrative example: Consider how increased encephalization may be a response to the necessity of flexible responses in ever changing environments (see Calvin, 2004, where he puts forward the "brain for all seasons" hypothesis; Reader & Laland, 2003). However, increased encephalization, an adaptation in some mammal lineages including our own, is not an anti-modularist phenomenon: on the contrary, modularists may advocate encephalization as a developmental mechanism that increases (not diminishes) modular organization. As neuroscientist Georg Striedter explains in his textbook on brain evolution (Striedter, 2004), as the total number of neurons increases, the density of dendrite connectivity among neurons decreases. Hence, an increase in the relative size of the brain will normally have as a side-effect an increase in the partition of brain areas. This partition may reasonably be called

modularization of the brain. This general principle is also well observed in human brains. Thus the hominid adaptation known as encephalization may arguably have had “domain-specific” roots through the partition and input specialization in some areas. Nevertheless, it is difficult to maintain that encephalization is an adaptive response to a very specific environmental problem (Marino, 2005). Thus, some of the new modular systems resulting from encephalization may be not the response of the organism to a specific niche, but rather may contribute to the fitness of its owner by increasing flexibility in the behavioral responses to several ecological domains and general problems. For instance, encephalization in birds has been related to increased habitat diversification, increased colonizing capacities and higher scores of adaptiveness to a wider range of environments generally. Encephalization in the primate lineage has been probably related to the complexification of the social life and the necessity of giving flexible behavioral responses in a Machiavellian arms race. Thus, Robin Dunbar found significant correlations between neocortex size and social group size, as support for his well-known social brain hypothesis (Dunbar, 2006). But yet not every brain area correlates with social group size in primates. Frontal areas seem to be the relevant ones in this respect. Therefore, although the often extracted general moral of the story is that a bigger brain may provide the computational capacity required for a more complex social world, the details of the story show that it is the functional specialization of some parts over others that better predicts the relevant relationships. Hence it is right to say that encephalization involves modularization.

Against blank slate myths we naturally endorse the camp of evolutionary rationality. Against fallacious arguments about what can evolve and what cannot, we ascribe to the evolutionary views on developmental plasticity. But against the idea that evolution for enhanced plasticity could only support domain-general mechanisms, we contend that domain-specific mechanisms can better increase adaptation to varying environments. These domain-specific mechanisms we call “modules for all seasons”. Recent critics of evolutionary psychology have overlooked their possibility, but we put them forward as a promising way to reconcile Evolutionary Psychology with cultural diversity.

## **8. The «modules for all seasons» as a useful tool for studying the evolution of cultural cognition**

We have shown that one of the arguments of Evolutionary Psychology in support of the specificity of ecological domains for the evolution of cognition (the evolvability argument) rests firstly on a

misunderstanding on what an input-domain is (sections 4-6), and secondly, on a very narrow idea and generalization on what an adaptation in the Neo-Darwinian framework is supposed to be (sections 5 and 7). We hence call for the abandon of an unnecessary identification of the input-domains of modular systems with its evolutionary ecological function.

Furthermore, at the beginning of this paper we introduce the distinction between what we called the “big mistake” and “big success” hypotheses in the explanation of human cultural cognition. We tried to show that this distinction is real (not a straw-man), although it is better seen as points in a continuum, than as a one-or-the-other affair. That opposition has motivated debates on the evolution of human cognition ranging from psychology to anthropology and philosophy. We contend that many of these debates are ill posed: we think that both approaches should be seen as complementary, rather than alternative. We pursue the idea of a module for all seasons in this vein: a contradictory idea if you misunderstand what a module is and you take the aforementioned approaches all too seriously; but actually a plausible and already operative idea if a proper understanding of domain specificity is assumed.

When studying the evolutionary process that resulted in our powerful cognitive abilities, many of the proposed biological adaptations are clearly generalist in scope. We have already mentioned the case of encephalization. Other examples are the evolution of the prolongation of the cerebral phases of synaptogenesis in human infants and, more generally, the development of secondary altriciality in the human life cycle. These adaptations, even if eventually arising from specific selection pressures, would have rapidly given “a free lunch” for much of cultural cognition. In consequence, we argue that evolutionary psychologists should take seriously complex views on the function of human cultural adaptations as those argued in the “variability selection hypothesis” of paleoanthropologist Rick Potts or the “built for speed” hypothesis of Boyd and Richerson. These views are not necessarily anti-modularist and certainly not anti-adaptationist. Reciprocally, philosophers and anthropologists should get more interested in modular approaches such as those inspired by evolutionary psychology. These approaches can provide them with useful tools to understand the flexibility of human cognition.

There is nothing wrong in the notion of evolving ecological generalists, either in diet, or in psychology. But as we have seen, evolutionary psychologists have usually denied the very possibility of the evolution of a generalist cognitive mechanism. One recent example is Peter Carruthers’ rejection of some of the rationales behind the “one major new adaptation hypothesis”. Although most of his demystifying of the

arguments in favor of a saltationist event in the evolution of cognition is right, he also makes use of some of the arguments we have criticized in the previous pages:

“In addition to being intrinsically implausible, the ‘one new adaptation’ account is inconsistent with the conclusion of the arguments from complexity and from learning. (It probably conflicts with the argument from computational frugality, too, which was also outlined in that chapter. For there are just too many different tasks that such a system would have to perform)” (Carruthers, 2006, p.152).

The conclusion is true -we agree with the intrinsic flaw in “one unique major adaptation” views- although the argument is, in our opinion, incorrect: there are such adaptations to ecological frugality: these are the “modules for all seasons”. A module for all seasons is a domain-specific module whose ecological function has been evolutionarily adapted to a variety of environmental challenges. Once again you need to distinguish between proximate function and ecological function (sections 6 and 7). If the proximate function is well defined in relation to the treatment of a set of formally defined informations (its input-domain), the ecological function is vast due to what has been an evolution for developmental plasticity under complex, non-recurrent selection pressures. An example of such a modular system may be the language faculty (under the schema that we already suggested in section 6).

We now want to develop another example as it has been studied in the research of human mechanisms for social learning. Social learning is by many accounts a biological dimension that enhances the developmental plasticity of a species. It is actually seen as a kind of general problem-solver in response to the challenge of environmental change, by theoretical biologists, ethologists and anthropologists (Reader & Laland, 2003; Boyd & Richerson, 1985). In anthropology its function has been considered as intrinsically plastic in accordance to accounts such as the “variability selection hypothesis” of paleoanthropologist Rick Potts or the “built for speed” hypothesis of Boyd and Richerson. It has been said (neuroscientist William Calvin dixit) that we evolved a “brain for all seasons”. The “brain for all seasons” and “variability selection hypotheses” have been typically opposed to the modularity framework (Sterelny, 2004) and social learning may thus be seen as a privileged arena of confrontation. But as with encephalization, social learning can be decomposed into modular mechanisms: these ones would also be paradigmatic “modules for all seasons”. Thus when cognitive developmental psychologists such as Michael Tomasello study how the great apes including humans process social information, they decompose the process into mechanisms of attention-

following, expectation of cooperativeness, and intentionality-reading mechanisms, as precursors of theory of mind: all of them are plausible candidates for modular systems. Similarly, psychologists Gyury Gergely and Gergely Csibra have developed a theory of modular mechanisms of cultural transmission by means of teaching and pedagogy. The modular system is decomposable into domain-specific submodules whose range of inputs are relatively well defined, such as eye contact, face preference, contingent reactivity, protoconversation and infant directed speech sensibility, name recognition, gaze shift following, pointing understanding, etc. as well as a relevance module containing expectations of pedagogical contents and a motivation to participate in those social interactions.

These modular systems in a domain such as social learning may indeed function as general adapters that exploit the acquired specializations of a given population. In this sense, they are the sort of adaptation that would have contributed to increase human behavioral plasticity. Admittedly, this social transmission adaptations are not enough to explain the universals of human cognition (see Carruther's list of 22 for instance), and thus we are not reducing human adaptedness to a one-shot affair of a "one" big major adaptation. Nevertheless, it is the short of adaptation or preadaptation that would have vastly increased the range of possible evolutionary pressures that our ancestors' mind was put into.<sup>10</sup> And thus their contribution to the human evolutionary cognitive success is in many ways prior to other members of the list of human universals. For better or for worse, the quest for the missing link in the evolution of cognition still seems to have good days ahead.

## Acknowledgements

Gracias a un par de intensas conversaciones con Damián Justo, así como en virtud de algunas críticas constructivas del seminario NaSH (Naturalismo y Humanidades) del Jean Nicod Institute de París, y de los siempre acertados comentarios de Toni Gomila y los participantes del Interuniversity Workshop este artículo es más claro y preciso que en sus versiones previas aunque tal vez no tanto como podría serlo gracias a tan ilustre público. De ello somos enteramente responsables. Por último

<sup>10</sup> There is a story to be told along the lines of the special case of niche construction dubbed the Baldwin effect. Unfortunately we do not have the space to develop it here. But see Papineau (2005) or Viciano (in preparation) for detailed accounts of how social learning modules may induce a massive modularization of the mind in evolutionary time.

pero no menos importante, Toni Gomila merece un agradecimiento especial por el ánimo que como organizador del coloquio transmitió a este trabajo colaborativo.

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