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Why Evolutionary Psychology Still Can't Explain Human Intelligence

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Abstract

One distinctive feature of human intelligence is a high level of flexibility for problem-solving. Human thought is flexible roughly in the sense that , "there is *no end* to the kinds of problems human reason can deal with" (Horgan & Tienson, 1996). However, no theory to date has adequately explained such unique capacity. Recently, evolutionary psychologists have confronted this challenge by building models that have the potential to generate human flexibility via interaction of modules and learning (Barrett, 2005; Carruthers, 2006b; Sperber & Hirschfeld, 2006; Sperber, 1994). The key idea is that our cognitive system can learn to self-assemble, out of our sophisticated adaptive toolbox, new mechanisms that solve significantly novel problems. In this paper, I identify a serious information routing problem, "the nativist input problem", distinct from the *a priori* and really real input problems previously launched against evolutionary psychology by Fodor (2000) and subsequently solved (Barrett, 2005; Pinker, 2005). The nativist input problem is, briefly, a crippling limitation to the range of contexts in which evolutionary psychology can handle information routing reliably. I argue that it undermines successful self-assembly required for these models to explain human flexibility, highlighting nativism as one of the most problematic commitments of evolutionary psychology.

Keywords: Evolutionary Psychology; Nativism; Carruthers; Human Intelligence; Flexibility; Input Problem; Information Routing

1. Introduction

One distinctive feature of human intelligence is a high level of flexibility at the types of problems it is capable of solving. Human thought is flexible roughly in the sense that , "there is *no end* to the kinds of problems human reason can deal with" (Horgan & Tienson, 1996). However, no theory to date has adequately explained such unique capacity. Recently, evolutionary psychologists have confronted this challenge by building models that has the potential to generate human flexibility via interaction of modules and learning (Barrett, 2005; Carruthers, 2006b; Sperber & Hirschfeld, 2006; Sperber, 1994). The key idea is our cognitive system can learn to self-assemble, out of our sophisticated adaptive toolkit, new mechanisms that solve particular novel problems. In this paper, I argue that these models fail because, per their nativist commitments, there is no resource for overcoming an important type of information routing problem—the "nativist input problem".[1] The nativist input problem is, briefly, a crippling limitation to the range of contexts in which evolutionary psychology can handle information routing reliably. I argue that it undermines successful self-assembly required for these models to explain human flexibility, highlighting nativism as one (perhaps, the most) problematic commitment of evolutionary psychology.

I begin (section 2) by introducing Evolutionary Psychology, focusing on the often-ignored epistemic commitments. Section 3 briefly explicates the capacity of human flexibility and points out a substantial explanatory gap in some recent models– there is no demonstration that interaction of modules solves novel problems. On the contrary, section 4 argues that while coordinating modules to solve novel problems requires reliable information routing in novel contexts, Evolutionary Psychological models that commit to the strongest version of nativism lack such capacity. Section 5 expands the argument against Evolutionary Psychological models that commit to a weaker version of nativism. It shows that learning, while compatible with a weaker version of nativism, will not help with the nativist input problem. One caveat: the strategy of this paper is to prove evolutionary psychology wrong on its own ground. So, I accept several of its potentially problematic assumptions for the sake of argument.

2. Evolutionary Psychology

Evolutionary psychology can be understood in the narrow and wide senses. In the wide sense, it amounts to a branch of cognitive science that takes understanding the etiology of mind to be an integral part of a complete psychology and employs an evolutionary approach in its investigation of cognitive processes (Jeffares & Sterelny, 2012). The target of this paper however is evolutionary psychology in the narrow sense. Evolutionary psychology in the narrow sense (aka, Evolutionary Psychology) has nativism as one of its additional commitments (Barkow, Cosmides, & Tooby, 1995; Pinker, 1997)

The central thesis of Evolutionary Psychology is the massive modularity hypothesis, according to which the human cognitive system is composed of a large number of Darwinian modules exclusively. Understood architecturally, Darwinian modules are innate, domain-specific, and informationally encapsulated computational mechanisms. More importantly, a Darwinian module, characterized in

[1] The nativist input problem is distinct from the *a priori* and really real input problems (Fodor, 2000), both of which, I think, have been solved (Barrett, 2005; Pinker, 2005). I'll discuss them briefly in section 4.

epistemic terms, implements exclusively innate, domain-specific, heuristics (aka, Darwinian heuristics) (Carruthers, 2006a). I will use Darwinian modules and Darwinian heuristics interchangeably in the rest of the paper.

Heuristics are principles or algorithms for information processing that, if applied correctly without performance errors, will provide (1) satisficing solutions, (2) in selective contexts, (3) within the constraint of tractable computation. Consider the "Do-what-the-majority-do heuristic": If you see the majority of your peers display a behavior, engage in the same behavior (Gigerenzer, 2006). Studies have reported such imitation behaviors in animals and humans. For instance, female guppies base their mate choice on the preferences of other female guppies (Dugatkin, 1992). This heuristic provides satisficing solution as it produces "decision" good enough, often enough, but not necessarily optimal or best. Also, it works reliably (in a satisficing sense) only in some contexts and becomes unreliable in other contexts. "…a heuristic is not good or bad, rational or irrational per se, but only relative to an environment" (Gigerenzer, 2006).

Some qualifications are necessary here. In the following, when I describe a heuristic being reliable without further qualification, I mean "reliable in a satisficing sense, that is, good enough, often enough according to some particular standard". Also, I use the term 'context' technically to refer to the information structure of some particular combination of a cognitive task and its embedding environment. For example, the mate selection task in a guppie's natural environment has a distinctive information structure and counts as one distinctive context. Note that it is a delicate issue concerning the individuation of context types. In order to capture the unique feature of human flexibility to solve problems in a wide range of novel contexts, we need to adopt a coarse-grained approach to individuation—that is, only contexts that differ significantly in terms of their information structures would count as different types of contexts. This is to avoid trivializing the unique capacity of human flexibility when one adopt a fine-grained approach and count a context that only bears a minor difference as novel.

Finally, in a human cognitive system, assessing all relevant information to solve a typical nondemonstrative reasoning task, i.e., abductive reasoning, requires intractable computation (Fodor, 2000). A computational process is tractable, roughly, if it does not require more time and resources than what a normal human being can be expected to possess for completing a task. Heuristics are computationally tractable as they do not assess all task-relevant information. Importantly, the tractability of heuristic is connected to its context-dependent, satisficing performance. Because a heuristic has built-in "knowledge" about some contexts, it "knows" certain relevant information can be approximated or ignored without significant loss in performance in those contexts. The female guppie's "decision" is adaptive, but far from optimal in the sense of allowing it to find the best mate. In addition, this fast and frugal heuristic only works in an environment that is relatively stable for reliable social information to emerge (Boyd & Richerson, 1988).

Information encapsulation, at its core, is a restriction on the range of information a mechanism can use as resource when performing tasks. A mechanism is encapsulated if it cannot be influenced by most of the relevant information held in the mind during the process of a task (Carruthers, 2006b).[2] In fact, information encapsulation is one way of implementing heuristics in a computational mechanism.

Domain-specificity is a **proper-function** concept in evolutionary psychology (Tooby & Cosmides, 1995). A mechanism/heuristic is domain-specific if **it is designed (e.g., by evolution)** to solve problems in a limited range of contexts. Note that this definition is distinct from Fodor's original conception of domain-specificity, which refers to a limitation on the types of representations acceptable as inputs (Fodor, 1983).

The heuristic employed by female guppies is domain-specific if it is designed by evolution to solve mate selection problem in their natural environment. Relatedly, evolutionary psychologists believe Darwinian modules are **adaptions** produced by natural selection to solve adaptive problems (Tooby & Cosmides, 1995). **Adaptive problems** are recurrent problems whose solution promotes fitness directly or indirectly in the environment of evolutionary adaption (EEA) in pre-human and early human history, such as Pleistocene.

Note that there are two distinct types of context-specificity discussed so far. A Darwinian heuristic has reliable performance only in some particular types of contexts, and it has a proper function (i.e., it is designed by evolution) to solve some small range of particular adaptive problems. While both *proper function* and *adaptive problem* are causal-historical concepts (i.e., roughly, whether a particular problem is an adaptive problem depends on its causal-historical property), the *context-dependent performance* is not (i.e., the individuation of contexts, when evaluating a heuristic's context-dependent performance, does not rely on causal-historical property). This has an important complication: a context that has the same information structure as an adaptive problem may not be that adaptive problem because it does not have the same causal-historical property, i.e., being a particular type of significant problem that drives human evolution in Pleistocene. In the following, I shall call all contexts that have the same information structures as some adaptive problems **"adaptive contexts".**

Finally, Darwinian modules are **innate** in the sense that, roughly, they are not the result of learning (Samuels, 2002, 2009). We should note that the concept of Darwinian module defined so far is one that accords with the strongest

[2] It remains debatable how the restriction on information has to be implemented for a mechanism to qualify as encapsulated (Samuels, 2006). Here, I assume a liberal notion most charitable to evolutionary psychology.

version of nativism. It is fair to say that few Evolutionary Psychologists adhere to such an unreasonable view of nativism now. However, I find it instructional to start with the argument against the strongest version of Evolutionary Psychology (Section 4) and modify the argument to address the more moderate and reasonable ones (Section 5), and it is the strategy this paper will follow.

In sum, evolutionary psychologists conceive of human mind as composed exclusively of Darwinian modules, that is, innate and informationally encapsulated computational mechanisms that are designed to solve some limited range of adaptive problems.

3. The Puzzle, Solution, and Explanatory Gap

The puzzle of human flexibility, simply put, is the question of how a non-magical, purely mechanistic system, i.e., our cognitive system, can produce satisficing solutions in a wide range of adaptive and novel (i.e., non-adaptive) contexts. Here, I take it as a *prima facie* fact that we can solve problems in a wide range of novel contexts.[3] For example, Antarctica excursion is possible because we are capable of devising satisficing solutions in an environment so different from the environment we evolved that evolution cannot prepare our Pleistocene ancestors for. Some evolutionary psychologists falsely believe the puzzle is solved simply through massive modularity hypothesis, that human beings are "flexible .... because their minds contain so many different modules" (Pinker, 1995, p. 410). Obviously, the puzzle remain unanswered because the fact that our mind's capacity of problem-solving in a massive numbers of adaptive contexts does not explain problem-solving in novel contexts. Additional explanatory steps need to be taken.

Here is where some recent models of evolutionary psychology come in (Barrett, 2005; Carruthers, 2006b; Sperber & Hirschfeld, 2006; Sperber, 1994). They aim to show that interactions of Darwinian modules can generate human flexibility. Without doing full justice to Carruther's original and complex account, I will summarize its key features and point out incorporated contributions from other authors:

1. Human mind is constituted by a massive numbers of perceptual, motor, and central (i.e., belief-generating, desire-generating, and practical reasoning) modules (Figure 1).

2. Each module has a recognition front-end, a mechanism that identifies representations that fit its triggering conditions. Although each module is designed to process certain types of representations (its proper input domain), it will process any representations that fit its triggering conditions (its actual input domain) (Sperber & Hirschfeld, 2006; Sperber, 1994).

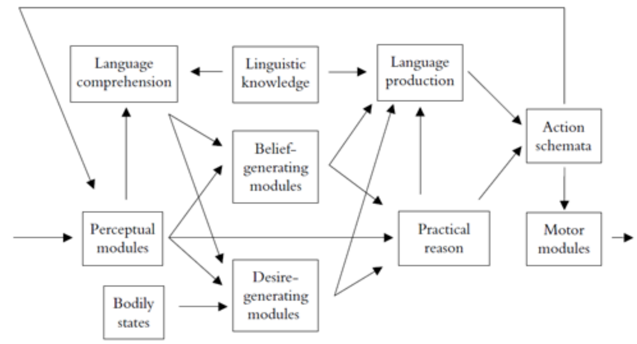

Figure 1 A simplified representation of the massive modular architecture of human mind. (Carruthers, 2006b)

3. There is a common blackboard structure through which perceptual information is broadcast to belief-generating and desire-generating modules. If a representation satisfies the triggering conditions of a module, the module will be activated to process it. If there are multiple representations meeting the condition of a particular module, they compete to become inputs to the module. Other representations may also modulate the module's activities at the same time, like enzymes interacting and influencing the production of proteins in the cells (Barrett, 2005). Similarly, belief-generating and desire-generating modules compete to send information to practical reasoning modules, which in turn compete for control of motor modules (Figure 2). In fact, the blackboard structure, the recognition front-ends, and the competition/cooperation of modules work together as a soft-assembled information routing module (Clark, 1998, p. 42).

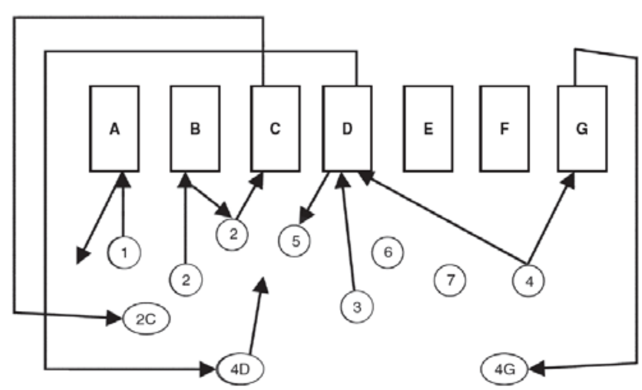

Figure 2 A possible implementation of the blackboard structure (Barrett, 2005).

4. When human beings engage in problem-solving, some relevant motor plan is activated in response to demand of the problem. This results in the broadcasting of it efferent copy, that is, representations of what would be perceived as a result of the relevant actions. The efferent copy is processed by belief- and desire-generating modules to determine whether the problem can be solved through performing the action.

5. If the problem can be solved through performing the action, the motor plan will be executed.

[3] See (Potts, 1996; Richerson & Boyd, 2012; Sterelny, 2006, 2012) for discussion on how contemporary problems differ substantially in terms of information structure from adaptive problems.

6. If otherwise, some variation may be generated, randomly or through some heuristic processes, in various modules to produce a different motor plan— a type of trial-and-error reinforcement learning. (I will put this point and the relevant learning issue aside until section 5.)

7. The step 4-6 can be repeated until a satisfying solution emerges or until the agent gives up (Figure 1).

This account indeed looks plausible. The recognition front-end explains how human mind can process novel representations. The soft-assembled routing module allows wider information accessibility and potentially more flexible information routing. The cycles of mental operation with learning capacity promises to produce novel solutions. However, the account remains incomplete because (1) the ability to process novel representations does not entail the ability to process them *successfully*; (2) the soft-assembled routing modules are adaptations and implements rather inflexible Darwinian heuristics[4]; most importantly, there is a significant explanatory gap: (3) while cycles of interactions among Darwinian modules can no doubt produce some solutions, we have no reason to believe that the interaction is capable of producing satisficing solutions in novel contexts—let me call this explanatory gap the "novel/adaptive gap". Without a detailed story linking this gap, the claim that interactions produce flexibility is not so much an explanation as a statement of the problem given the commitments of evolutionary psychology. I suspect Carruthers is aware of it himself:

> …my claim isn't really that [the puzzle of flexibility] has now been solved. It is rather that there is some reason to hope that it can be solved, and that we can at least begin to understand human cognitive processes in massively modular terms. (Carruthers, 2003, p. 520)

4. The Nativist Input Problem

In this section, I argue that evolutionary psychology, due to the nativist input problem, has no theoretical resource to bridge the novel/adaptive gap. I first lay out the main argument, and then provide additional support for its most crucial premise:

(1) For a set of Darwinian modules to provide a satisficing solution in a novel context, their interactions must amount to a series of information processing that result in a satisficing solution.

(2) Such series of information processing is constituted by information passing through the right (serial, parallel, or cyclical) sequences of modules.

(3) Hence, it is important that routing modules involved in the series ensure that information is routed to the right downstream modules at each step.[5]

(4) However, evolutionary psychology cannot handle information routing in a wide range of novel contexts—i.e., the nativist input problem.

(C) As a result, it cannot reliably provide solution in a wide range of novel contexts.

Of course, the nativist input problem (premise 4) is the controversial one here. Various input problems have been raised (Fodor, 1983, 2000, 2008) and solved (Barrett, 2005; Pinker, 2005). What makes the nativist input problem different? Here, I demonstrate that the nativist input problem is a distinctive and substantial problem, and unlike previous versions of input problems, one that evolutionary psychology has no resource to overcome:

Because heuristics are not universal machines but have context-dependent performance,

(1) To solve nondemonstrative reasoning tasks reliably with heuristics, an additional "routing" decision is required to figure out the identity of the present context so that the appropriate heuristic can be selected to perform the task (Fodor, 2000, p. 44).

The significance of premise (1) is often missed because evolutionary psychologists often take for granted that individuating contexts is rather unproblematic. For example, Carruthers suggests "heuristics '[could] be cued automatically by particular subject matters'; but he says nothing about how 'subject matters' might be individuated…" (Fodor, 2008, p. 118). In fact,

(2) The routing decision is usually also a species of nondemonstrative reasoning (Fodor, 2000, p. 43).

Ignoring the premise (2) has dire consequence because,

(3) For evolutionary psychologists, all nondemonstrative reasoning, including the routing decision, is approximated by Darwinian heuristic, but

(4) Darwinian heuristics cannot reliably perform nondemonstrative reasoning in a wide range of novel contexts.

As we discussed earlier, Darwinian heuristics **are innate domain-specific heuristics** that are designed to solve particular adaptive problems. Proper function does not entail actual performance: That a Darwinian heuristic has the proper function for solving a particular adaptive problem does not imply or guarantee that its actual performance is reliable in the corresponding adaptive context and unreliable otherwise. Yet, given a strong and consistent evolutionary force (i.e., natural selection), its actual performance should

[4] The fact that enzyme model is a heuristic solution is not made clear in Barrett's original paper, especially the important feature of context-dependent performance. As Barrett puts it, "One can have an enzymatic system…in which only the 'correct' reactions are catalyzed" (Barrett, 2005, p. 270), implying enzymatic system is reliable across all contexts. However, cellular enzymes are only reliable in the cellular environment it is designed for and similarly for enzymatic routing mechanisms.

[5] I will, for the sake of argument, assume that humans have all the necessary building blocks (Darwinian non-routing modules) to assemble mechanisms for novel problems we can solve.

track its proper function. That is, Darwinian modules have competence for reliable performance in their specialized adaptive contexts. However, natural selection is not a reliable force in producing competence for reliable performance outside of adaptive contexts; as a result, we cannot expect Darwinian modules to possess competence for reliable performance in a wide range of novel contexts. As a result,

(C) Evolutionary psychology cannot handle information routing in a wide range of novel contexts.

The nativist input problem is distinct from the *a priori* input problem because it is not concerned about the limiting architectural features of modules, i.e., informational encapsulation and limited input domain (Fodor, 2000, p. 72).[6] It is also distinct from the really real input problem, which criticizes the epistemic property of heuristics in general—that they do not have reliable performance in all contexts (Fodor, 2000, p. 77).[7] Instead, the nativist input problem criticizes the epistemic property of Darwinian heuristics in particular—they cannot have reliable performance in a wide range of *novel* contexts.

5. How About Learning?

So far, I've ignored the learning issue for the sake of simpler argument presentation. Naturally, it invites a powerful and legitimate objection: The nativist input problem attacks a straw man. Evolutionary psychology, though a nativist program, is compatible with learning. In fact, many evolutionary psychologists would happily acknowledge that, "most innate cognitive modules are domain-specific learning mechanisms that generate the working modules of acquired cognitive competence" (Sperber, 2005, p. 57). So, a Darwinian learning module can acquire the necessary competence for routing information in a wide range of novel contexts. In this section, I show that the kind of learning evolutionary psychologists need is not the kind of learning they can have. The nativist input problem remains.

Both nativists and empiricists agree that through a lifetime of development, we come to acquire a large numbers of psychological traits. What they disagree about is "the character of the psychological systems that underlie the acquisition of psychological traits" (Margolis & Laurence, 2012, p. 3). So, what kind of learning mechanism are nativists committed to? We can answer this question by looking into the central argument for nativism, the poverty of stimulus argument (PoSA) (Samuels, 2002, p. 237). PoSA supports nativism for a particular psychological trait by establishing the following features in the learning mechanism responsible for its acquisition:

(a) The learning mechanism contains substantial innate domain-specific information.

The PoSA usually establishes this by showing that: based on the observation, information in a learner's environment is inadequate to account for the acquired trait, or even if adequate, the subject has insufficient time to acquire necessary information to develop the trait (Margolis & Laurence, 2012, p. 6). Because the input is inadequate, what is missing has to be made up somewhere—potentially by innate information in the learning mechanism. But PoSA does not merely establish what is learned goes beyond what is experienced. It also shows that,

(b) Some of the innate domain-specific information acts as strong bias or constraint in the learning process (e.g., in hypothesis generation).

This feature is established by showing what is learned surpasses what is experienced in a way that cannot be accounted for without these innate bias and constraint, because "… the correct hypotheses are not at all the most natural ones for an unbiased learner…. Indeed, there are numerous alternatives that would be more natural to such a learner but that would lead the learner astray" (Margolis & Laurence, 2012, p. 8). Finally, because of the abundant domain-specific innate information, it suggests that:

(c) This mechanism has a fairly limited and constrained learning capacity.

Now, it is clear why PoSA supports nativism—it gives innate information and constraint a much more substantial role over learning in the acquisition of the particular trait. So, while both nativists and anti-nativists take innate constraints and experiences as determinants of the learning outcome, i.e., the acquired trait, only nativists believe that innate constraints, rather than experiences, are the more powerful determinants of the learning outcome. Intuitively, we can think of all possible learning outcomes in a domain as organized in a multi-dimensional traits space. Experiences direct the learning trajectory, while innate constraints constitute sloped boundaries surrounding areas in the space, facilitating the trajectory into areas within the boundary while impeding it from going beyond. Importantly, nativism requires the innate constraints to form a strong boundary, surrounding a relatively small area and impeding learning trajectory from going beyond. Take one influential nativist theory in linguistics as an example: Chomsky (1975) argues that principles of Universal Grammar (UG) are innately represented in the human language faculty and interact with each children's linguistic experiences to determine the specific language the child will acquire. Significantly, UG restricts the range of possible languages the child can acquire by constraining the range of linguistic hypotheses available for confirmation by experiences. So, only linguistic hypotheses that lied within the boundary of UG could ever be confirmed and acquired, even if the child were exposed to some hypothetic language

[6] I deliberately define informational encapsulation liberally to be compatible with the solution to the *a priori* input problem—an access-general, process-specific routing mechanism (Barrett, 2005).

[7] As Pinker (2005) points out, this criticism does not really undermine evolutionary psychology because actual human performance is in fact not reliable in all context.

the structure of which differed significantly from all possible human languages.

This is bad news for Evolutionary Psychologists. Although they can incorporate learning into their models (e.g., step 6 in Carruthers' account), it has to be highly constrained by innate domain-specific information, in our case, built in by evolution because it facilitates acquiring "knowledge" for reliable information routing in the EEA. As a result, the innate constraints should form a strong boundary in the trait space, surrounding a small area containing the knowledge for reliable information routing in adaptive contexts. As adaptive and novel contexts have very different information structures, knowledge required for one is very different from that for the other. That is, they should locate relatively far away from each other in the traits space, and strong innate constraints that facilitate the acquisition of one are likely to prevent the acquisition of the other. In fact, claiming that a learning mechanism can acquire the knowledge necessary for a wide range of novel contexts is equivalent to denying the existence of strong innate constraints and therefore, nativism—something Evolutionary Psychologists cannot afford to do.

Perhaps, they can bite the bullet and claim that all contemporary contexts are really the same as, or very similar to, some adaptive contexts. So, the routing knowledge to be acquired falls within the boundary of the strong innate constraints. However, such move remains post-hoc until independent empirical supports for the similarity of the information structures of adaptive and contemporary contexts are provided. Give an example of what this would look like to make the point sink—how unlikely it is. In short, resorting to learning will not solve the nativist input problem because nativist learning cannot help Darwinian modules acquire competence for information routing in a wide range of novel contexts.

Conclusion

Evolutionary psychologists seek to explain human flexibility with models that allow interaction of modules to self-assemble new mechanisms that can solve a wide range of novel problems. However, even a sophisticated adaptive toolkit needs to be cleverly assembled to be of any use. These models, due to their nativist commitments, cannot acquire the necessary competence for intelligent self-assembly in order to bridge the novel/adaptive gap. The nativist input problem is why evolutionary psychology still cannot explain human intelligence.

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