MAKING COGNITION

DOXTDATOR

MAKING COGNITION:
TOWARDS AN EVOLUTIONARY PHILOSOPHY OF HUMAN COGNITION

By

BENJAMIN DOXTDATOR, B.A.

A Thesis

Submitted to the School of Graduate Studies in
Partial fulfillment of the requirements of
Masters Arts
McMaster University

Master of Arts (2006) McMaster University
(Philosophy) Hamilton, Ontario

TITLE: Making Cognition: Towards a Philosophical ...
AUTHOR: Benjamin Doxtdator, B.A. (McMaster University)
SUPERVISOR: Barry Allen

NUMBER OF PAGES: v, 117.

Abstract

In my thesis I argue against the four primary commitments of Evolutionary Psychology 1) Adaptationism, 2) Nativism, 3) Modularity, and 4) Computationalism.

In the second half of my thesis, I present an alternative view. I argue that many aspects of human cognition that Evolutionary Psychology take to be adaptations, are in fact spandrels, or by products of adaptation. Facts about human developmental neurobiology put further strain on the first three theses. I reconceptualize human cognition as a decoupled use of artifacts. I claim that this makes better sense of the phylogenic difference between humans and chimpanzees.

Acknowledgements

I owe a great debt to Barry Allen for supervising my MA thesis, my undergraduate thesis, and for inspiring me as a young undergraduate student. Without his support, encouragement, and his own philosophical work, my thesis would not have been possible.

My parents, Brian and Mary Lou, gave me all the encouragement and support that anyone could ever want. With love, I dedicate my thesis to them.

There are many students who I owe thanks too, in fact too many to name. I would however like to thank David Rondell for making sure that I never wandered far from being a good pragmatist.

Making Cognition

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Introduction

In this thesis, I have two main goals. First, to present a critique of Evolutionary Psychology whose leading champions endorse the idea that cognition is a form of computation, to which they add a particular interpretation of evolutionary theory. Between the last common ancestor we shared with chimpanzees and anatomically modern humans, Evolutionary Psychologists see the emergence of a multitude of special purpose adaptations, called modules, each fitted to solve a restricted class of adaptive problems. My second aim is to offer my own proposal on the evolution of human cognition. I argue that significant aspects of human cognition are not the product of natural selection, but are instead byproducts or spandrels associated with other adaptations. Thus Evolutionary Psychology is only one possible evolutionary psychology, or just one way to bring Darwin and psychology together. Although, my critical project does bear some productive fruit, and it is instructive to see where Evolutionary Psychology goes wrong.

My thesis is that human cognition is largely made, and depends evolutionarily and developmentally on the things we make, our artifacts. One key adaptation is the ability to understand others as intentional agents. I argue that ability to share attention in conjunction with our relatively immature brain at birth, combined with the likelihood that brain expansion in the hominid line would have resulted in beneficial spandrels, is an attractive alternative to Evolutionary Psychology.

Any evolutionary perspective on human cognition should be able to explain two facts. First, the flexibility that is characteristic of human cognition that is especially evident when we look at chimpanzee cognition. Evolutionary Psychology bets that we achieve such flexibility via battalions of special purpose modules working in conjunction. This is the thesis that the mind is like a Swiss Army Knife, outfitted with special purposes implements for equally special tasks. Second, it should be able to explain the gap between whatever natural selection left off and the many things that we do that evolution has not supplied an adaptation for. If, as Evolutionary Psychologists suppose, we still have a Stone Age Mind, how do we end up appreciating symphonies or driving automobiles? The commitment to a strong form of nativism, according to which we still have a Stone Age Mind despite the difference between the Pleistocene and contemporary human developmental environments, in conjunction with the idea that human cognition consists of nothing but special purpose modules, is the undoing of Evolutionary Psychology.

In Chapter 1, I set out the main claims of Evolutionary Psychology and begin to argue against adaptationism as well as the massive modularity thesis. I introduce the idea of spandrels, and begin my argument that significant aspects of human cognition are byproducts of adaptation. In Chapter 2, I argue on neurological and evolutionary grounds against the possibility that natural selection could have targeted many independent cognitive modules. Our neurological development is so tightly integrated that any beneficial mutation would likely carry spandrels along with it. Indeed, what we know about the evolution and development of human neurology as well as the pattern of human evolution we can glean from artifacts strongly suggests that our cognitive evolution did not consist of a gradual adding-on of special-purpose cognitive modules.

Finally, in Chapter 3 I propose two ingredients for thinking about human cognition. First is the idea that human cognition crucially depends on our artifacts. Second, I propose that our cognition is decoupled in an important sense. Kim Sterelny has argued that humans are the only decoupled representers, that we are able to use information in flexible ways to drive a large repertoire of responses. Decoupled cognition and artifacts depend upon each other. The first step that hominids made into broad-banded response was the making of stone tools about 2.5 million years ago. One key adaptation is shared attention which allows us to understand others as intentional agents, and emerges early in development, at around 9 months. Shared attentional abilities probably did not emerge much before anatomically modern humans did, about 200,000 years ago. After the so-called Upper Paleolithic revolution, about 40-60,000 years ago, cognition and artifacts entered into an open ended relationship. This thesis is about how our cognition became decoupled and how that goes hand in hand with our artifacts; in short, about how human cognition was made.

Chapter 1: Evolutionary Psychology

In this chapter I lay out the main claims of Evolutionary Psychology drawing primarily on the works of Steven Pinker, Leda Cosmides, and John Tooby. Evolutionary Psychology, so construed, is not just a hypothesis about the evolutionary origin of a particular cognitive adaptation, nor is it a particular interpretation of the major events in human evolution. It is instead a sweeping theory of how evolution operates, and how we should expect evolution to have organized human cognition and the brain. There are four main theses that Evolutionary Psychology endorses. Adaptationism and computationalism form the two core commitments. Evolution is supposed to operate almost exclusively by means of natural selection, and cognition is supposed to be computation or symbol crunching. The third commitment is to massive modularity. Through the process of natural selection, a massive number of cognitive modules are supposed to have been accumulated in the hominid lineage. Each module is supposed to have algorithms specific to a particular so-called adaptive problem that hominids might have faced. The fourth commitment is to nativism, or the idea that development proceeds from genetic information or a genetic program. Evolutionary Psychologists put the genome at the centre of evolution and development. Evolution is supposed to deposit information or programs in the genome that then construct cognitive modules or innate ideas in development that are tasked to solving adaptive problems.

There are two overarching problems for any evolutionary theory of human cognition. First, any theory should account for the cognitive flexibility that humans display, and I argue that this flexibility is radically non-modular. Second, an evolutionary theory of human cognition should be able to make sense of the many cognitive performances of humans that natural selection could not possibly have wired in modules for, such as the ability to drive a car or follow a recipe in a cook book.

First I sketch the relationship between culture and cognition that Evolutionary Psychology proposes. Then I turn to the adaptationist program and introduce the idea of cognitive modules. In criticizing adaptationism I make two points. We need to abandon the lock-and-key model of evolution, where natural selection is supposed to take organisms and make them fit their environment. An alternative conception of evolution makes use of the idea of niche construction, whereby organisms influence the selection pressures that act on them by modifying their environments. Later I argue that the transition from niche-construction, were hominids modified their environments, to culture, where humans make their environments is key to understanding the evolution of human cognition.

My second criticism of adaptationism argues that not everything Evolutionary Psychology supposes is an adaptation was actually conferred directly by natural selection. Here I introduce Gould's and Lewnontin's concept of spandrels, which are byproducts of adaptations. This concept is crucial to the argument I make. I later propose that we have fewer adaptations than Evolutionary Psychology proposes, and that many aspects of our uniquely human cognition are spandrels. I criticize the idea of a massively modular cognitive architecture, or that such an architecture would explain the cognitive flexibility that is characteristic of humans.

The Blank Slate vs. The Stone Age Mind

The take off point for Evolutionary Psychologists Leda Cosmides and John Tooby is a criticism of the Blank Slate psychology that the social sciences have inherited from John Locke. Blank Slate psychology views the mind as general purpose computer with no innate ideas. Evolutionary

Psychology wants to hang onto the idea that cognition is computing. To escape the Blank Slate, they make two proposals. First they propose to view the mind as a Swiss Army Knife, packed with special purpose adaptations, or modules, each fitted to a specific adaptive problem that our hominid ancestors encountered in the Pleistocene. Second, they claim that we still have a Stone Age Mind in our modern skulls. The Pleistocene environment that we evolved in is radically different from our current developmental environment, which leads Evolutionary Psychology into a strong form of nativism which argues that our cognitive architecture is innate in the sense of being encoded in our genes. In Chapter 2, I criticize this brand of gene-centrism. Moreover, the Stone Age Mind thesis puts enormous pressure on an explanation of how we manage to cognitively cope in a modern world.

Gene-centered views of evolution and development are overly reductionistic. At the same time, Evolutionary Psychology grants too much autonomy to cognition as information-processing. When these two ideas are put together, it misleads Evolutionary Psychologists into thinking that they can consider adaptive problems and information-processing solutions independently of whether either are biologically possible. If the machinery of cognition is encoded in the information of the genome, any facts about development are beside the point. Added to this is the assumption that information processing problems are relatively independent of one another, so that each needs to be solved by specific modules. I argue that cognition and development are both highly integrated, and it is a mistake to think that new cognitive modules could be easily added in, or that the most significant aspects of human cognition could be subserved by modules.

The only difference between the Evolutionary Psychology conception of the relation between culture and cognition and the Blank Slate model they are trying to overcome is the direction representations are supposed to flow in. Instead of representations coming from the side of experience, the world, or the external environment into the mind, representations are supposed to go from the genome into the mind, and from there out into experience and culture. Culture is just a product of our innately contentful psychology. "Thus," Tooby and Cosmides claim, "the problem of learning 'culture' lies in deducing the hidden representations and regulatory elements embedded in others' minds that are responsible for generating their behavior."[1] Part of my aim in Chapter 3 is to challenge both the Blank Slate and the Stone Age Mind by challenging their conception of the relationship between culture and cognition. Instead of viewing representations as the stuff culture is made of, I want to change the focus to artifacts, especially material ones in the first instance. But that is a way off, so into the problem of bringing evolution to bear on the study of human cognition is where I will begin.

Evolution and The Adaptationist Program

It was Darwin's accomplishment in On the Origin of Species to propose natural selection as a *mechanism* to explain the *fact* of evolution. Yet, Darwin believed that evolution was not synonymous with natural selection, since the latter "has been the main but not exclusive means of modification."[2] Richard Lewontin characterizes natural selection with these propositions:

1. There is variation in morphological, physiological, and behavioral traits among members of a species (the principle of variation);

[1] John Tooby and Leda Cosmides, "The psychological foundations of culture," *The Adapted Mind: Evolutionary psychology and the generation of culture,* eds. Jerome H. Barkow and L. Cosmides, (London: Oxford University Press, 1992) 118.
[2] Charles Darwin, *On the Origin of Species* (1859), (Cambridge, MA: Harvard University Press, 1964) p. 6.

2. The variation is in part heritable, so that individuals resemble their parents more than they resemble unrelated individuals, (the principle of heredity);
3. different variants leave different numbers of offspring either in immediate or in remote generations (the principle of differential fitness).[3]

Heritability does not mean coded in the genes, and it is not an account of how traits are built in development. It is a statistical measure of resemblance given a trait and what we take to be fixed background conditions.[4] Yet, it is common to propose that genes fill three roles: as the particles of inheritance, the units of evolutionary selection, and the developmental prime movers. A strand that runs through my argument is that Evolutionary Psychology and cognitive science have failed to take development seriously. The power of genes has been oversold, and when we dismantle this conception of what genes are and do, a lot of Evolutionary Psychology falls by the side.

The power of natural selection is that it can act cumulatively over geological time. Everyone's favorite example is the eye. It is a highly organized piece of biology that serves a very particular purpose, vision. The eye appears designed, and an evolutionary account will have to explain this without the appeal to a Designer. Natural selection can act cumulatively, starting with simple photo-receptors, and mutations (variations) that are heritable might occasionally be produced that will increase the fitness of an organism's descendents. We do not have to get full blown eyes all in one go. Evolution is not directed, but provided that each step on the pathway to eyes is heritable and advantageous in its own right, over geological time eyes may be produced.

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[3] Richard C. Lewontin, "Adaptation," *Conceptual Issues in Evolutionary Biology: an anthology*, ed. Elliot Sober, MIT, 1984) 244.
[4] Kim Sterelny and Paul E. Griffiths, *Sex and Death: An Introduction to the Philosophy of Biology*, (Chicago: University of Chicago, 1999) 35.

The power of natural selection should properly instill wonder. However, the adaptationists have taken natural selection to be so powerful and pervasive that little else matters. Development, which produces variation, is taken to be secondary. Often it is assumed that there are few constraints on variability, so that if there is a selection pressure, natural selection will produce adaptations. They in effect think that all physiological and hence psychological mechanisms (because they must be implemented biologically) are like the eye. How do we pick out what traits are adaptations? Here adaptationists use the idea of biological function and complex organization, the appearance of design, as the hallmarks of adaptation. What they add to this is a particular gloss on heritability. Most variability is supposed to spring from the genes, and hence be inherited.

In the Descent of Man, Darwin acknowledged the novelties of human cognition, but always stressed the continuity with lower animals. Darwin focused on *descent with modification*, where as adaptationists are quite happy to look for adaptations that spring up ex nihilo, without any concern for phylogeny. Tooby and Cosmides see a "fundamental difference" between these two approaches, claiming that the adaptationist approach is interested in "niche-differentiated mental abilities unique to the species being investigated."[5] This segregation is unhelpful, and judging by their track records, phylogeny-minded researchers like Michael Tomasello have done more to illuminate human and primate social cognition than Evolutionary Psychology has.[6] This has everything to do with the fact that it may be impossible to figure out what the unique mental abilities of humans are without careful study of other primates, not to mention detailed attention to the

[5] J. Tooby and L. Cosmides, "Adaptation Versus Phylogeny: The Role of Animal Psychology in the Study of Human Behavior," *The International Journal of Comparative Psychology* 2.3 (1989) 178.
[6] See for example, Michael Tomasello and Josep Call, *Primate cognition,* (London: Oxford University Press, 1997)

archaeological record. Without these constraints, adaptationism quickly becomes another rationalist armchair sport.

The adaptationist program in Evolutionary Psychology is committed to two importantly distinct research strategies. First, forward engineering, which aims to discover psychological mechanisms using adaptationist logic, and then experimentally confirm that modern humans have these mechanisms. Second, Evolutionary Psychologists attempt to explain all *functional* features as adaptations. This is often referred to as reverse engineering, and it assumes that what is there is there for a reason, its function. Though the first commitment might be a research program, this second commitment is open to the charge that it is just *post hoc* storytelling. Why do we have noses? To hold up glasses, to be sure. Evolutionary Psychologists believe that they can avoid this sort of nonsense by pressing into service a definition of biological function. Thus, holding up glasses is something that noses can do, but the function of a nose is something different; it has to be the solution to a longstanding evolutionary problem. This conception of function means having a function conferred by a history of selection. An immediate problem is that the nose is not something just bolted on to our faces. It is part of the skeletal structure of our faces, and the structure of our upper-respiratory tract. It is difficult to tell an evolutionary story about any one trait in isolation, and it is unlikely that any traits have one unique function they were selected for.

Tooby and Cosmides define an adaptation as "a reliably developing structure in the organism, which, because it meshes with the recurrent structure of the world, causes the solution to an adaptive problem."[7] Evolutionary Psychology takes reliably developing to mean innate, or somehow genetically coded. Tooby and Cosmides put it this way: "Genes are the means by which functional design features replicate themselves from

[7] John Tooby and Leda Cosmides, "The psychological foundations of culture," *Barkow, Jerome H* ED); Cosmides, Leda (ED); et al. (1992). The adapted mind: Evolutionary psychology and the generation of culture (pp. 19-136). London, Oxford University Press. xii, 666 pp. 104.

parent to offspring. They can be thought of as particles of design."[8] Steven Pinker summarizes his similar view of cognitive evolution in two claims. First, "Behavior itself did not evolve; what evolved was the mind." For Evolutionary Psychologists, this means that the focus should be on special-purpose information processing adaptations. Second, he claims that, "The ultimate goal that the mind was designed to attain is maximizing the number of copies of the genes that created it."[9] An 'adaptive' mind is just the genes' way of propagating themselves. So, according to their adaptationist commitment, all of the interesting parts of cognition will turn out to be adaptations. Second, they believe in a strong gene-centered account of evolution. So what exactly are our cognitive adaptations supposed to be like?

Cognitive adaptations, according to Evolutionary Psychology, are supposed to be modules. Modularity is a hot topic in disciplines ranging from evolutionary and developmental biology, to cognitive science, evolutionary psychology, and artificial intelligence. The only problem is that there is rarely any agreement about what modularity is supposed to mean. At a first pass, modules are relatively autonomous and internally integrated units in a hierarchy of functionally individuated mechanisms. Evolutionary Psychologists claim that there are modules for language, perception, intuitive mechanics, food, justice, and mating, just to name a few.[10] Within the adaptationist programme, modules are somewhat synonymous with adaptations, ways to 'bolt on' new cognitive processes or structures, as Peter Carruthers puts it.[11] Modules are also more or less synonymous with innate bodies of information, since it is assumed a lot of cognitive adaptations are innate ideas. I will start by explaining the origins of the concept of modularity,

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[8] John Tooby and Leda Cosmides, "Conceptual Foundations of Evolutionary Psychology," *The Handbook of Evolutionary Psychology,* ed. David M Buss, Wiley, 2005) 21.
[9] Steven Pinker, "How the mind works," *New York, NY, US: W* W. Norton & Co, Inc.1997). xii, 660 pp. (660)43.
[10] Steven Pinker, *The Language Instinct,* (New York: William Morrow & Co, 1994) , 420.
[11] Peter Carruthers, "The Mind Is a System of Modules Shaped by Natural Selection," 10.

and then outline how Evolutionary Psychology plans to take it over and argue for a massively modular mind.

When Fodor wrote The Modularity of Mind (1983), he borrowed the idea of a module from Chomsky's work on language, and formalized and extended it to other areas of cognition. Chomsky simultaneously revived nativism and started the modularity revolution, and indeed for him the two appear to be co-extensive. Our 'language organ' just is an innate body of propositional knowledge.[12] On the other hand, when he calls it a "mental organ" he also means to stress that it is a part of biology, like vision or the circulatory system.[13] If modular theories of language are plausible, then it in no way follows that we should expect the mind to be massively modular. Language is a unique phenomenon, and it would be a mistake to conclude that the mind must be made up of lots of modules just because a modular story of language might be plausible. The same goes for Fodor's modules which I discuss next. Both conceptions of modularity were invoked to explain some very specific cognitive phenomena, and not as a way to describe cognition across the board.

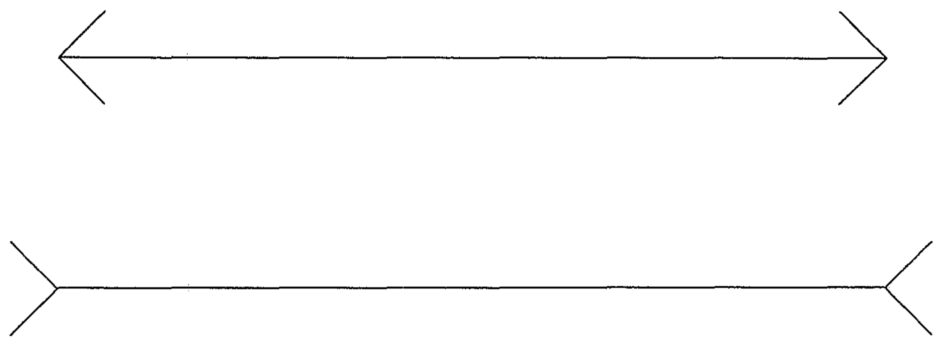
Modules, for Fodor, are defined by two features. First, they are domain-specific. Modules are supposed to have mechanisms or processes that allow them to answer only a certain range of questions. For example, a module for face recognition would contain innate information or processes that would only work on face representations, and not help us recognize automobiles. Second, modules are supposed to be informationally encapsulated. This means that modules are limited in the range of information they can consult in deciding what answers to provide.[14] For example, our face recognition

[12] 'Knowledge' does not mean justified, true belief, but rather something closer to just belief or information. It is not clear that the information in the language organ is even the kind of thing that can be true or false.

[13] Noam Chomsky, *Rules and Representations,* (New York: Columbia University Press, 1980) 60.

[14] Jerry A. Fodor, *The Modularity of Mind,* (Cambridge: MIT, 1983) 113.

module may have access to things like eye color, or lip size, but not to features like smell or height. Informational encapsulation is an extremely important property as it may allow modules to avoid the frame problem, or computational explosion. For example, the more background information a device has access to, the more computations it has to perform to reach a decision.[15] The classic example of encapsulation, or cognitive impenetrability,[16] is the Muller-Lyer illusion.



Even though we may know that the two lines are the same length, our visual system is encapsulated with respect to this information, and the illusion persists. Modules are supposed to be encapsulated like reflexes, but unlike them also computational.[17] If someone tries to poke you in the eye, you blink, even if you have very good information elsewhere that this person would always stop short of touching your eyeball. Encapsulation seals the modules off from our background beliefs.

[15] The full list of properties that Fodor attributes to modules are being mandatory, inaccessible, fast, domain specific, informationally encapsulated, shallow outputs, fixed neural architecture, and innate. The other properties are largely as consequence of being domain-specific and informationally encapsulated.
[16] Zenon Pylyshyn, *Computation and Cognition: a foundation for cognitive science*, (Cambridge: MIT, 1984) 250.
[17] Fodor, Jerry A., *The Modularity of Mind*, 72.

As Evolutionary Psychology conceives of them, modules are made up of unique algorithms and innate ideas, specifically tailored to solve an adaptive problem. The problems that modules are supposed to solve constitute their domain, and they are not supposed to work at all outside that domain, or at least not very well. As Tooby and Cosmides put it, "our cognitive architecture resembles a confederation of hundreds or thousands of functionally dedicated computers (often called modules) designed to solve adaptive problems endemic to our hunter-gatherer ancestors."[18] Tooby and Cosmides outline several arguments for massive modularity. I will first outline what Richard Samuels calls the solvability arguments for Massive Modularity.[19]

First, what counts as successful behavior or error differs from domain to domain.[20] For example, an organism that takes a strategy from one domain, say taste preference for nutritious food, and applies it to every domain, say mate selection, would "choose a very strange mate indeed." This could be an argument either for a unique algorithm for each module, or an argument for innate ideas for each module. Second, they argue that even within domains, individuals cannot learn within their lifetimes what is good for them. You cannot learn from experience the negative fitness effects of inbreeding, yet we are supposed to have an instinct against incest. This is a straightforward poverty of the stimulus argument, and again it does not necessarily argue for specific algorithms as much as it does for innate ideas. In a recent paper, Tooby and Cosmides explicitly put the burden on innate

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[18] , John Tooby and Leda Cosmides, "Forward," *Mindblindess,* ed. Simon Baron-Cohen, MIT, 1995) xiii.
[19] Richard Samuels, "What brains won't tell us about the mind: A critique of the neurobiological argument against representational nativism," *Mind & Language* 13.4 (1998), 589.
[20] John Tooby and Leda Cosmides, "The psychological foundations of culture," *Barkow, Jerome H* ED); Cosmides, Leda (ED); et al. (1992). The adapted mind: Evolutionary psychology and the generation of culture (pp. 19-136). London, Oxford University Press. xii, 666 pp. 111.

ideas, arguing our motivational structures do not represent anything, and so they must be innate.[21]

A third argument for modularity, focusing on encapsulation, is an attempt to save computationalism from the so-called frame problem. Tooby and Cosmides claim that "the more generally framed problems are, the more computational systems suffer from combinatorial explosion."[22] But, even a specifically framed problem can suffer from combinatorial explosion. Solutions to problems like "should I share food" can draw on potentially any information because potentially any information is relevant. For this computation to be tractable, we somehow need to isolate this module from a lot of our background information. Yet, there does not seem to be any principled way of deciding in advance what information it might need to have access to. If the answer is, any information relevant to the problem, then this means potentially all information. And the fact is that *we can* bring to bear potentially any information on the problem of food sharing. Try to think of information that could not possibly be brought to bear on food sharing or mate choice. It is unlikely that much of our problem solving abilities are encapsulated in any interesting sense.

One candidate for a cognitive module is the so-called theory of mind ability, or the ability to attribute beliefs and desires to others. However, there are persuasive reasons to consider this a decidedly non-modular process. My figuring out what you believe or desire on a given occasion requires that I integrate a lot of background information. I might rely on remarks that you have made in the past, my general knowledge of how people behave in certain situations, or perhaps even what I heard on the news this morning.

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[21] John Tooby, Leda Cosmides, and H Clark Barrett, "Resolving the Debate on Innate Ideas," *The Innate Mind: Structure and Contents*, eds. P. Carruthers, Stephen Laurence, and Steven Stich, Oxford University Press, 2005) .

[22] John Tooby and Leda Cosmides, "The psychological foundations of culture," *Barkow, Jerome H* ED); Cosmides, Leda (ED); et al. (1992). The adapted mind: Evolutionary psychology and the generation of culture (pp. 19-136). London, Oxford University Press. xii, 666 pp. , 112.

There could be no general algorithm for figuring out what someone believes, and as Sterelny and Currie put it, there is nothing that we are systematically blind to when we make social judgments.[23] And once we give up on the idea that cognitive modules are encapsulated to any interesting extent, we have to give up on massive modularity as a solution to computational explosion, or the frame problem. Massive modularity was supposed to "solve the frame problem by devising a theory of the human mind for which no frame problem would arise." But we know that is not how human cognition works.[24]

It seems that for any cognitive module that Evolutionary Psychology posits, it will be surrounded by non-modular processes. Fodor postulates that certain low-level perceptual processes are modules because they are stimulus driven and encapsulated with respect to the rest of our knowledge. An example would be the cognitive processes that give rise to the Muller-Lyer illusion. Yet, most cognitive modules presuppose some sophisticated processing upstream. That is, they typically do not operate on sensory data, but instead on sophisticated cognitive categories. Thus modules for mating presuppose the kind of cognition that produces a conceptual category like potential mate. It is unlikely that a non-modular process could identify possible mates from the rest of the objects we encounter. Downstream, modules presuppose non-modular processes when it comes to figuring out what to do. I want to push this point a bit further with an example from the literature.

Randy Gallistel is a psychologist whose research concerns learning in non-human animals, specifically special purpose learning mechanisms. He has also argued that modules are the route to flexible cognition. *Cataglyphis bicolor* is a desert ant that is able to navigate back to its nest after foraging for food by using path integration. On its way home, it runs in more or less a

[23] Gregory Currie and Kim Sterelny, "How to Think About the Modularity of Mind-Reading," *The Philosophical Quarterly* 50.199 (2000) ,149.
[24] Currie, Gregory and Sterelny, Kim, "How to Think About the Modularity of Mind-Reading," *The Philosophical Quarterly* 153.

straight line, even though the path it took to find food was long and winding, often going in one direction, and then turning and going in another. Path integration involves computations that figure out how far you have moved from your starting point and in which direction, which may be represented by a vector. Additionally, the organism must somehow keep track of time so it can compute how long it should follow the vector back home.[25] This is an impressive example of what evolution can do, and if anything is a module, this ant's path integration system is. From this, Gallistel infers that to claim that any organisms, including us, have non-modular, or general purpose learning process would be "equivalent to assuming that there is a general purpose sensory organ, which solves the problem of sensing."[26] Continuing this analogy, learning modules require specialized mechanisms "whose structure is as specific to a particular learning problem as the structure of a sensory organ like the eye or ear is specific to a particular modality." [27]

Here is the problem with this line of thought. First, this example of a module, if it is one, is such a rigid, stereotyped instinct that it is a mistake to try to take from it a lesson about how human cognition is organized. More importantly, if your theory requires structure specific mechanisms for each different learning problem, this will lead you into enormous trouble. We can learn to make curries, ride bicycles, fly airplanes, do calculus, play violin, and even learn how to do really good caricatures of people with their favorite baseball players who were kicked out of the pros for illegal betting. I doubt that any of these learning problems have a common specific structure, so must we then have separate modules for each of them? It is vastly implausible that evolution gave us modules specific to each of these

[25] Randy Gallistel, "The replacement of general-purpose learning models with adaptively specialized learning modules.," *The New Cognitive Neuroscience (second edition),* ed. Michael Gazzaniga, MIT, 2000)
[26] Gallistel, Randy, "The replacement of general-purpose learning models with adaptively specialized learning modules.," *The New Cognitive Neuroscience (second edition)*1.
[27] Ibid, 1.

problems. The other option is to claim that whatever modules evolution did give us, they are somehow able to solve these problems even though the problems are outside of their proper domain. But again, the whole point of modules is that they are supposed to have algorithms that are effective only within their evolutionary domain, and in some cases, the modules are not even supposed to be 'turned on' outside of their domain.

The following section looks at the relationship between modules and their proprietary domains. I mount an argument what counts as an adaptive problem depends on how we cognitively deal with it. This goes some way to undermining the idea that we can figure out what cognitive modules humans have from generating hypothetical information-processing. Humans are able to cognitively deal with the world in very broad banded, non-modular ways, and this is already a powerful objection to the massive modularity thesis.

Forward Engineering from Adaptive Problems

Modular cognition the way Evolutionary Psychology conceives of it will be guaranteed to produce inflexible cognition agents. It is not possible that natural selection has outfitted humans with a module for each cognitive problem we routinely deal with. In this section, I argue against the forward engineering claim of adaptationism. Since evolution is supposed to fit the organism to its environment like a key to a lock, Evolutionary Psychology claims that we can made good predictions about the organization of human cognition by hypothesizing what problems our hominid ancestors might have faced in the Pleistocene. There are three main problems with this line of thought. First, the Pleistocene was not uniform selective environment. I argue in this section that the variability of Pleistocene environments is a good reason to reject the idea that we have modules that fit specific adaptive problems. Second, hominids were prolific niche-constructors, actively modifying selection pressures through making artifacts. If it is useful to think of humans as occupying a cognitive niche, it is a niche they constructed and not one posing independent adaptive problems. Third, adaptive problems are defined by how organisms cognitively deal with the environment and each other. The way hominids coped with the environment and each other strongly argues for non-modular cognition. In the following section, I criticize the reverse engineering half of the adaptationist program, and introduce the concept of spandrels, which are byproducts of adaptations.

Though everyone acknowledges that natural selection is not the exclusive force of evolution, Evolutionary Psychologists, and adaptationists in general, never put this truism into practice. They commit themselves to explaining practically everything in terms of adaptations. Evolutionary Psychologists also claim that adaptationism is an interesting research programme; if we look at the adaptive problems that our ancestors would have faced, we can infer and discover what psychological adaptations we have.[28]

The idea that form follows function has been as pernicious in engineering as it has been in biology. David Pye argues that "When any useful thing is designed the shape of it is in no way imposed on the designer, or determined by any influence outside him, or entailed."[29] Form does not follow function, and those who like artifact analogies would do well to read Pye with careful attention. If I tell you that I have designed something to keep time, the form of the artifact is radically underdetermined. It could range from Big Ben, to a $10,000 Tag Heur, to a cheap digital watch, to a sun-dial.

According to Lewens, the same problem plagues adaptationist inferences from problems to solutions because "If all we know of an artifact is the broad problems that it was designed to solve, then this will tell us very

[28], Tooby, John and Cosmides, Leda, "Forward," *Mindblindess*, Xv.

[29], David Pye, *The Nature and Aesthetics of Design,* (London: Barrie and Jenkins, 1978) , 14.

little about its structure or inner workings."[30] Yet, in biology there are some constraints that do not operate in the world of human made artifacts. Detailed theories of function will still leave us short of what solutions to expect. We need detailed theories of brain development in conjunction with evolutionary thinking broadly construed to figure out what is going to count as a separate trait, and to illuminate what the structures of these traits are. As I argue later, the brain is such a tightly integrated organ that it is nearly impossible for an adaptation to selectively modify its information processing without having widespread changes in the rest of the brain, and this constrains the proliferation of psychological adaptations.

As Evolutionary Psychologists often point out, adaptationist functional analysis presupposes stable adaptive problems. What sort of adaptive problems pre-exist their solution? Probably none. Lewontin argues that, "To maintain that organisms adapt to the environment is to maintain that such ecological niches exist in the absence of organisms and that evolution consists in filling these empty and preexistent niches." He calls this the lock and key model of adaptations.[31] Against the idea that the environment poses problems that adaptations solve, Olding-Smee et al. argue that any organism-environment 'matches' should instead be thought of "as the dynamical products of a two-way process involving organisms both responding to their environments, and changing their environments through niche construction."[32] Organisms commonly modify their environments and the selection pressures that act on them are defined by a feed-back loop of which they are a part.

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[30] Tim Lewens, *Organisms and Artifacts: Design in Nature and Elsewhere,* (Cambridge: MIT, 2004) 60.
[31] Lewontin, Richard C., "Adaptation," *Conceptual Issues in Evolutionary Biology: an anthology*, 237-8.
[32] , John F Olding-Smee, Kevin Laland, and Marcus Feldman, *Niche Construction: The Neglected Process in Evolution,* (Princeton: Princeton University Press, 2003) , 240.

Pinker claims that humans filled in the cognitive niche.[33] But there was no cognitive niche before humans *made* a cognitive niche.[34] Take tool-use as an example. Early *Homo* did not suddenly find themselves with reduced jaws, the need for increased meat in their diet to sustain their energy-expensive larger brains, and *then* have the problem of making tools. They would have been an ecologically unviable species if they had to wait for a genetic mutation to supply a solution to a problem so that selection could then act on it. Ditto for language.

Another problem with trying to forward engineer the organization of the human mind is that there is no reason to think that anything we can imagine having been an adaptive problem was solved by the evolution of an adaptation. Solving some problems may enhance fitness, but it is a strong claim to suppose that organisms must have solved every problem we can cook up.[35] Thinking up adaptive problems is relatively cheap and unconstrained compared to natural selection acting on random variations over geological time. Buss, an adaptationist, points out that "Evolution by natural selection is a slow process, so there will often be a lag in time between a new adaptive problem and the evolution of a mechanism designed to solve it."[36] Yet he fails to see that this largely undermines the forward engineering half of the adaptationist program. If adaptive problems are of a do-or-die nature, the organisms will simply die if they have to wait for a solution supplied by random variation and natural selection.

Niles Eldredge has argued that, "Natural selection will seldom – if ever – take a species living in one place and modify that species as time goes on

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[33] Steven Pinker, "Language as an adaptation to the cognitive niche," Christiansen, Morten H ED); Kirby, Simon (ED). (2003). *Language evolution. Studies in the evolution of language* (pp. 16-37). London, Oxford University Press. xvii, 395 pp. 27.
[34] David J. Buller, *Adapting Minds: Evolutionary Psychology and the Persistent Quest for Human Nature*, (Cambridge, Massachusetts: MIT, 2005) ,100.
[35] Grantham and Nichols, 58.
[36] D. M. Buss, M. G. Haselton, T. K. Shackelford, A. L. Bleske, and J. C. Wakefield, "Adaptations, exaptations, and spandrels," *Am.Psychol.* 53.5 (1998), 537.

to meet the challenge of changing environmental conditions. Species get out, finding recognizable habitat as long as they can possibly do so."[37] How many species in the rain forests would you say are holding their ground and adapting under the new selection pressures generated by deforestation? Given the extinction statistics, not many. Niche construction and seeking out viable habitats are the first and most important resource for organisms, and these can rapidly modulate selection pressures.

Adaptations, on the lock and key model that Evolutionary Psychology endorses, presuppose a relatively stable environment in which natural selection works. What they call the Environment of Evolutionary Adaptedness (EEA) defines stable problems to which evolution is supposed to supply the solutions, the adaptations. The EEA is the *statistical average* of the Pleistocene environment, from roughly 1.8 million years ago (mya) to 10,000 ya. By using the statistical average, it is supposed to be possible to bring longstanding problems into view. But we should be suspicious that the statistical average is biologically meaningful, for "it may not represent the selective environment of any population."[38] This is a problem for Evolutionary Psychologists, and one that they have not faced up to. From at least 1.8 mya, we find hominid species in diverse environments from *erectus* in China and Java, to *ergaster* in East Africa, and there have been at least 8 cycles from glacial to interglacial in the last 1.5 million years, as well as numerous smaller oscillations.[39] Another consideration that Kim Sterelny raises is that hominids are adapted not to any fixed environments but rather to such variability.[40] We should not expect hominids to have adaptations that track the structure of particular adaptive problems. Instead, as Richard Potts puts

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[37] Eldredge, 176.
[38] Kim Sterelny, *Thought in a Hostile World: The Evolution of Human Cognition,* (Oxford: Blackwell, 2003) , 162.
[39] Steven Mithen, *The Prehistory of the Mind: The Cognitive Origins of Art and Science*, (New York: Thames & Hudson, 1996) , 32.
[40] Sterelny, Kim, *Thought in a Hostile World: The Evolution of Human Cognition*,162.

it, we should expect variability selection to produce adaptations that "result in flexible, novel responses to surroundings and diversity in the adaptive repertoire."[41]

Sterelny and Griffiths have convincingly argued that we are unable specify the adaptive problems with enough precision to be able to infer the existence of specific cognitive adaptations. Even if form did follow function, we have the problem of figuring out at what grain we are to specify adaptive problems. How many problems is mate choice? Is the problem, when should I cheat on my current partner? Or is it, when and how should I punishing cheating? Or, when should I leave my current partner and look for new mating options?[42] Whether or not these count as different problems depends on facts about human cognition. If we use the same 'module' to handle all of these, then mate choice is just one problem. The possibility of contemplating infidelity, and thus of infidelity being a problem *for* the organism, depends on the existence of cognitive processes that facilitate such contemplation. Without such processes or modules, the organism will either be faithful or promiscuous, and there may be consequences to pay for either option. But only the existence of a cognitive module that tracks these options and consequences would make this a cognitive problem for the organism. "It is not the existence of a single problem confronting the organism that explains the module, but the existence of the module that explains why we think of mate choice as a single problem."[43]

Atkinson and Wheeler have expanded the grain problem in two dimensions. Not only must we specify exactly what is going to count as a problem, we must also figure out what parts of the organism count as

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[41] , Richard Potts, "Variability Selection in Hominid Evolution," *Evolutionary Anthropology* 7.(1998) 86.
[42] Sterelny, Kim and Griffiths, Paul E., *Sex and Death: An Introduction to the Philosophy of Biology.*
[43] Sterelny and Griffiths, *Sex and Death*, 329.

solutions.[44] This brings us back to the problem of individuating traits that I raised earlier. Buller has argued that there is no reliable chain of inference from problems to psychological adaptations because we need to know about the pre-existing psychological structures that were modified.[45] If we cannot use adaptive problems to illuminate our psychology without knowledge of our psychology in the first place, then even the idea that there are stable social problems comes under attack. We cannot figure out what the social problems were and whether or not there was anything like a stable social EEA without antecedent knowledge about human social cognition. Figuring out what counts as a trait, then, is going to take more than looking to so-called adaptive problems. However, Evolutionary Psychologists may argue that because they propose *modular* psychological mechanisms, it would be irrelevant to discuss any other mechanisms that were already in place. Neurologically, this is implausible. Brains are not like computer towers with empty slots, so that all one has to do is buy some extra memory and snap it in. Having a neurology that supports tool-making is going to require different development routes for adding new modules for language, and so on. Second, even if psychological mechanisms were radically modular, in order to figure out what problems evolving hominids faced, we would need to know what other modules were already in place – because a large part of any adaptive problems must have been what other hominids were doing. Yet, these problems are also likely to be unstable. Any problems that other hominids pose may be met with a variety of short-term niche-construction solutions that actively modify the nature of the problem.

Forward-engineering from adaptive problems to adaptations is supposed to give us access to the mind that we might not otherwise have. It

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[44] Anthony P. Atkinson and Michael Wheeler, "The Grain of Domains: The Evolutionary-Psychological Case Against Domain-General Cognition," *Mind and Language*, vol 19, no. 2, pp. 147-176, April 2004, (2).
[45] , Buller, David J., *Adapting Minds: Evolutionary Psychology and the Persistent Quest for Human Nature* 93, 104.

is supposed to be one way of getting around the problem that we cannot get into the mind and study its functional organization as we might be able to with a clock. Yet the irony of this research program is largely lost on Evolutionary Psychology. As one philosopher puts it, "Evolutionary psychology is likely to be successful only if we already have a rich store of information regarding the development and organization of the mind; however, it is precisely this information that adaptive thinking is supposed to deliver."[46]

The Critique of Gould and Lewontin

The target of Gould and Lewontin's 1977 paper "The Spandrels of San Marco" is what Peter Godfrey-Smith has called empirical adaptationism. This is the thesis that natural selection is the most powerful causal factor in evolution, and that there are few developmental or variational constraints upon it. Attending to problems, or selection pressures is predictive of what solutions, or adaptations, organisms will have.[47] The message that Gould and Lewontin offer is that not all features of organisms are adaptations, *even ones that appear 'designed.'* Their critique is not epistemological, that we cannot know what a given structure was selected for, but ontological, not all structures are selected.

Gould and Lewontin use the term "spandrel" to refer to characters that are by-products of adaptations but were not themselves selected. Spandrels may later acquire functionality but they are not adaptations. In St. Mark's Cathedral (Venice), there are paintings of various religious icons contained in the spaces where the rounded arches of the domed roof intersect. The temptation is to view the paintings as the cause of these spaces, what the

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[46] , Lewens, Tim, *Organisms and Artifacts: Design in Nature and Elsewhere*, 62.
[47] Peter Godfrey-Smith, "Three Kinds of Adaptationism," In S.H. Orzack and E. Sober (eds.), *Adaptationism and Optimality*, Cambridge University Press, 2001, pp. 335-357.

spaces are there for. Yet "Spandrels – the tapering triangular spaces formed by the intersection of two rounded arches at right angles – are *necessary architectural byproducts* of mounting a dome on rounded arches."[48] These spaces contain paintings, but the spaces are not there for the purpose of containing paintings; they are an example of functionality without function (in the teleological sense). These paintings and the spaces the occupy are "a secondary epiphenomenon representing a fruitful use of available parts, not a cause of the entire system."[49]

Dennett and Evolutionary Psychologists frequently use design as a metaphor for natural selection. This metaphor is misleading, because Darwin convincingly showed that there was no real design in the sense that requires a designer. Design is then short-hand for heritable variation that selection acted upon, gradually and cumulatively. However, design can also be the result of cultural elaboration – which would be a spandrel.[50] Reading and writing may appear to be designed, but we quite confidently know that we have no adaptations that were selected for the benefits that reading and writing convey. They are a cultural and not biological phenomenon. I suspect that the resistance to spandrels stems in part from the gene-centered view of evolution and development. On this view, all functional design comes from the genome, and if it is genetic, it was selected, hence it was an adaptation and not a spandrel. If you think that the design of the organism is contained in its genes, then this rules out the idea of interesting emergent features that might accompany adaptations.

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[48] , Stephen J. Gould and Richard C. Lewontin, "The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Program (1979)," *Conceptual Issues in Evolutionary Biology,* ed. Elliot Sober, (Cambridge: MIT, 1984) , 253.

[49] Ibid, 255.

[50] Dawkins, Dennett, and many other adaptationists argue that within culture, there is a process of natural selection acting on memes which are supposed to be analogous to genes. This view is highly implausible. In Chapter 3, I put forward a different picture of what human culture is.

Central to the adaptationist program is the idea that an organism can be atomized into traits that are independently acted upon by natural selection. For Ernst Mayr, though there is nothing wrong with asking what the function of a given structure or organ is, he also cautions us on how we are to decide what counts as traits that might have been selected. "It would indeed be absurd to atomize an organism into smaller and smaller traits and to continue to search for the ad hoc adaptation of each smallest component."[51] This problem looms large for Evolutionary Psychologists. They claim that the brain might be teeming with hundreds or thousands of adaptations, but offer no arguments for their assumption that it is neurologically possible for the brain to be divided into so many traits, each an independent target of selection. Indeed, I later argue that the development of neurology largely rules this possibility out, while at the same time lends support to the idea that we may have many neurological spandrels.

Conclusions

In this chapter I have presented two of the main claims of Evolutionary Psychology. Our mind is supposed to be outfitted with hundreds or thousands of cognitive modules, each tuned to a specific adaptive problem that our hominid ancestors might have faced in the Pleistocene. There are several reasons to doubt that claim. There are many cognitive 'problems' that natural selection could not have provided problem-specific adaptations for. Evolutionary Psychology has no obvious way of handling this objection. The whole point of modules is that they do not work well outside of their domain, and Evolutionary Psychology has failed to offer any plausible argument that

[51]Ernst Mayr, *Towards a New Philosophy of Biology: observations of an evolutionist,* Harvard, 1988) 152,

battalions of Pleistocene-geared cognitive modules could somehow work together to support the diverse manifestations of human cognition.

Chapter 2: Neurological Evolution and Development

Gene-Centrism in Evolution and Development

So far I have introduced two aspects of Evolutionary Psychology. Adaptationism, the thesis that evolution primarily operates via natural selection, argues that evolution has supplied humans with many cognitive modules, and leads to the claim that we have a massively modular mind. Together they make up the Swiss Army Knife conception of cognition. For each cognitive task we are supposed to have a specially suited implement. There is another strand in Evolutionary Psychology, a commitment to a strong form of nativism that leads its proponents to postulate that we still have a Stone Age Mind. The idea is that our cognitive architecture is supplied with a host of innate representations, and both modules and innate ideas are supposed to be strongly genetically determined.

Evolutionary Psychology views the information problems that hominids faced as autonomous in two ways. Each information problem is supposed to be autonomous from other ones, which leads to postulating unique modules for each problem. Second, information-processing problems float free of any considerations of neurological evolution, and whether or not it is plausible that through natural selection, a massive number of cognitive modules could have been independent targets of selection, and added to our neurology. Evolutionary Psychology also has a strong reductionistic bias, reducing evolutionary change and development to genetic information and programs. What ties the two strands together is a conception of information, and this will be the target of my critique in this chapter. I also make a positive argument. Where Evolutionary Psychology goes wrong is in the assumption that you could somehow 'add' cognitive modules to our brain independently of one another. I propose that there is good reason to think that because of the developmental constraints on our neurology, this is unlikely and that any changes to our neurology would carry byproducts or spandrels. My second proposal is that the developmental shift to a prolonged period of postnatal brain growth, the prolonged period of neurological plasticity, and infant dependency all are good reasons to be suspicious of the idea that natural selection has added lots of instincts in the form of cognitive modules. But first I turn to the problem with gene-centered accounts of evolution and development.

For natural selection to be cumulative, something must be passed on from one generation to the next. Gene selectionists take the units of heredity and the units of selection to be genes.[52] Organisms are termed interactors, which are supposed to be vehicles for the genes, or replicators, that construct them.[53] For example, Buss et al. claim that, "There must be genes for an adaptation because such genes are required for the passage of the adaptation from parents to offspring."[54] This seems to be the consensus view in Evolutionary Psychology, though they rarely mount a defense of it, and the trend in evolutionary biology has been to abandon gene-centrism.

George Williams got the gene-selectionist movement going in 1966. The gene-centered view is motivated by the apparent fact that "The natural selection of phenotypes cannot itself produce cumulative change, because phenotypes are extremely temporary manifestations." The same goes for any individual genotype, as any sexually reproducing organism's genotype is gone when it dies. What is needed is some conception of genes that can simultaneously play the two roles suggested by Maynard Smith.[55]

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[52] Sterelny, Kim and Griffiths, Paul E., Sex and Death: An Introduction to the Philosophy of Biology, p 39
[53] Ibid.
[54] , Buss, D. M., Haselton, M. G., Shackelford, T. K., Bleske, A. L., and Wakefield, J. C., "Adaptations, exaptations, and spandrels," *Am.Psychol.* 535.
[55] George C. Williams, *Adaptation and Natural Selection: A critique of some current evolutionary thought,* (New Jersy: Princeton University Press, 1966) 23-4.

"Developmental biology can be seen as the study of how information in the genome is translated into adult structure, and evolutionary biology of how the information came to be there in the first place."[56] Gene selectionism is only as viable as the gene-centered accounts of development that claim that the genome contains the design of the organism. Nativists aim to produce such a gene-centered account of development, arguing that developmental regularities are caused by an antecedent representation of that regularity contained in the genome in some form of information. First I will attack the specific case of gene-selectionism, and then I will turn to the broader problem of genetic information and development.

Sterelny and Griffiths argue that gene-selectionists must overcome a conceptual problem of specifying how the genotype and phenotype are related in some well behaved way.[57] To be the units of selection, genes must have some constant phenotypic effect. So we will need a conception of genes that fills this role. The only hitch is that the relationship between DNA sequences and the phenotype is "complex, indirect, and equivocal." This relationship is equivocal at many levels. First, many genes are *pleiotropic*, they can influence many traits, and many traits are *polygenic*, or are influenced by many genes.[58] Moreover, genes act *epistatically*, or in a non-linear fashion, so that the effect of a gene at a particular locus depends on other genes at other loci.[59] Even the relation between genes and proteins is indirect. The path from DNA to proteins is mediated by RNA. The same sequence of nucleic acids that make up DNA can be transcribed into different RNA sequences, which are then translated into proteins. We cannot

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[56] John Maynard Smith, "The Concept of Information in Biology," *Philosophy of Science* 67.(2000), 177.
[57] Sterelny, Kim and Griffiths, Paul E., *Sex and Death: An Introduction to the Philosophy of Biology*93.
[58] Ibid 127, 123.
[59] , William Wimsatt, "Reductionist Research Strategies and Their Basis in the Units of Selection Controversy (1980)," *Conceptual Issues in Evolutionary Biology,* ed. Elliot Sober, (Cambridge: MIT, 1984)

therefore identify genes with DNA sequences because these sequences do not have constant effects. "It would be wrong to suppose that DNA specifies proteins in the sense of uniquely determining a particular protein. Different RNA transcripts can be transcribed from the same DNA sequences."[60] Moreover, even if the DNA-protein relationship were well-behaved, the same protein can play many different roles in an organism.

The upshot is the nonlinearity of development and the possibility of emergent features is that what bit of DNA makes its way to a protein is so context-dependent that it severs any neat relationship between genes and resulting structures in the organism. Steven J. Gould argues that "The error of gene selectionists does not lie in their stubborn assertion of pure additivity in the face of such knowledge [the nonlinearities of development], but rather in their conceptual failure to recognize that this noncontroversial nonlinearity destroys their theory."[61] This non-linearity makes the reduction of the organism to genes impossible, because the phenotype is not the sum of its genes, and genes do not code for parts of the organism, and do not serve as unequivocal templates for proteins.

Tooby and Cosmides contend that "Selection should retain or discard alternative circuit designs from a species' neural architecture on the basis of how well the information-behavior relationships they produce promote their propagation of *the genetic basis of their designs*."[62] The upshot of the equivocal nature of the relationship between genes and organismic structures is that there may be no such thing as "the genetic basis" of the design of neural circuits that is not simultaneously the genetic basis of many other

[60] Sterelny, Kim and Griffiths, Paul E., *Sex and Death: An Introduction to the Philosophy of Biology*, 126.
[61] , Stephen J. Gould, *The Structure of Evolutionary Theory,* (Cambridge: Harvard, 2002) 627.
[62] Tooby, John and Cosmides, Leda, "Conceptual Foundations of Evolutionary Psychology," *The Handbook of Evolutionary Psychology*,13.

phenotypic characteristics. Gould puts it this way, "If bodies were unambiguous maps of their genes, then battling bits of DNA would display their colors externally and selection might act upon them directly. But bodies are no such thing."[63] Moreover, genes radically underdetermine the organism. There has been no success in cashing out exactly how genes contain all by themselves something like the design of the organism.

There is a close connection between gene-selectionist accounts of evolution and of development. Nativists about development, like Pinker, make to main claims. First, that what is innate is in some interesting sense not learned. "We do not learn to have a pancreas, and we do not learn to have a visual system, language acquisition, common sense, or feelings of love, friendship, and fairness."[64] Genetic information is proposed as a common factor that underlies our biology and our cognitive traits. If nativism just meant not learned, it would not be a thesis with much substance. One suggestion is that the debate about innateness is about what is part of our biological endowment, or more specifically what cognitive traits, are in some sense genetically determined.[65] Pinker claims that "Our physical organs owe their complex design to the *information* in the human genome, and so, I believe, do our mental organs."[66] The point here is not about a definition of what it is to be innate, indeed a recent article found some 26 definitions in current circulation.[67] My target is a particular mechanism proposed by Evolutionary Psychology to explain development, that of genetic information.

With the completion of the so-called human genome project, it appears that we have something on the order of 30,000 genes, where previous

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63 , Stephen J. Gould, "Caring Groups and Selfish Genes," *Conceptual Issues in Evolutionary Biology,* ed. Elliot Sober, (Cambridge: MIT, 1984) 123
64 Pinker, *How the Mind Works*, 31.
65 John Collins, "Nativism: In Defense of a Biological Understanding," *Philosophical Psychology* 18.2 (2005), 159.
66 Pinker, *How the Mind Works*, 31.
67 Matteo Mameli and Patrick Bateson, "Innateness and the Sciences," *Biology and Philosophy* 21.(2006).

estimates hoped that we closer to 100,000. In contrast, there are on the order of 10^{15} synapses in the human brain. Prima facie, there is a massive informational shortfall between what the genome can specify and the complexity of the brain. What is even more intriguing is that between the mouse and humans, there is no linear increase in number of genes.[68] Both species have about 30,000 genes, though human brains are three orders of magnitude larger and vastly more complicated. What is the proper conclusion to draw? First, we will have to give up the idea that the genome is a simple blueprint. The metaphor of the genome as a blueprint for the organism has fallen out of favor. Now everyone is an interactionist, claiming that they understand that both the environment and the genome contribute to development. Despite all the metaphorical shifts, "innate" still means something like coded in the genome. Thus, the environment can also play a causal role, but genes are supposed to be unique in playing an informational role, and by being a program that controls the developmental process. The internally rich informational structures posited by linguistics and cognitive science that are opposed to the informationally impoverished environmental stimuli *map onto* the informationally rich genome and the environment that acts to trigger these genetic programs.

According to the blueprint metaphor, there would have to be a correspondence between a bit of the blueprint and a bit of the resulting structure. Take for instance the blueprint of a building. In this case there would be a correspondence between the bit of the diagram that depicts, say, the room at the north-east corner of the second floor and the actual room at the north-east corner on the second floor. Given that there is no significant increase in the size of the genome across species such as mice and humans, the idea that the genome is a blueprint is clearly in trouble. To specify more structure, a blueprint must increase in size or resolution, both of which would

[68] Jean-Pierre Changeux, *The Physiology of Truth,* (Cambridge: Belknap Harvard, 2002) , 153.

translate into an increase in the size of the genome. The genome is not a blueprint, and no one uses this metaphor except in quotes.[69] Nativists instead claim that the genome is a recipe, or a set of instructions, for the construction of the organism. This account is supposed to avoid the pitfalls of preformationism, or the idea that the organism is somehow completely specified before development begins, and all that is left is for it to grow. According to the recipe or instructions metaphor, there are two kinds of genes, structural genes that act as protein templates, and regulatory genes that are able to turn on other genes in what Gary Marcus calls a cascade. What effect a gene has depends on where and when it is turned on.[70] Thus, the genome does not need to increase in size between the mouse and the human, but just needs to use the templates with different cascades.

However, genetic information and the conception of a genetic program is now biologically obsolete. Indeed "information" is best seen as a surrogate for a nonexistent technical concept, as it plays no explanatory role in molecular biology. When nativists refer to information, coding, or programs this is not metaphorical short hand, but simply a misleading view of development.[71] Gene-centrists have simply changed preformationist metaphors, from blueprints to information, recipes, and programs. Gary Marcus views each gene, structural or regulatory, as having two logical parts, first a protein template, and second, regulatory information, instructing when a gene should be turned on.[72] He endorses what he calls the Autonomous Agent Theory of genes, where genes should be seen as "developmental rules, " where "each gene acts like a single line in a computer program," with an 'if..., then...' structure so that genes would have information about what to

[69] Richard Dawkins, *The Blind Watchmaker,* (London: Penguin, 1986) 294.
[70] Ibid,, 296
[71] Sahotra Sarkar, "Decoding "Coding" - information and DNA," *Bioscience* 46.11 (1996) 857
[72] Gary F. Marcus, *The Birth of the Mind: How a tiny number of genes creates the complexity of human thought,* (Cambridge: Basic Books, 2004) , 59.

do and when to do it.[73] This view sees the "genome as a complex, dynamic set of self-regulating recipes that actively modulate every step of life." Even if 30,000 genes acting as a blueprint cannot accomplish the fine wiring of the brain needed for innate ideas, maybe a the genome acting as a recipe could. Though the genome is not a blueprint, it is "terrifically efficient description of how to build something of great complexity." Does this view avoid preformationism? I don't think so. This is a very weak sort of interactionism between asymmetrical developmental causes. "Genes provide options, and the environment (as well as the genes themselves, through their protein products) influences which options are taken."[74] Regulatory genes provide agency for the structural genes, constituting a program where "master control genes" "can set into motion extraordinarily complex developmental processes." The environment may trigger the cascade, but that is about all it is good for.[75]

Admittedly, this picture is rather vague. What are the contents of these instructions like? At what level at they pitched? Presumably they do not *say* "build a language acquisition device." Marcus gives an example of a gene-as-rule: "IF a cell is migrating AND it is a region that has less than a certain number of parts per million of the retinal-tectal gradient, THEN it should stop migrating." Is this really how genes work? No, and even Marcus knows it. He later adds that for the sake of simplicity he assumes that "genes guide actions, such as migration or further migration, rather than protein synthesis." [76] Genes are an important substrate, without which protein synthesis would

[73] Marcus, Gary F., *The Birth of the Mind: How a tiny number of genes creates the complexity of human thought* 42, 60.
[74] *Ibid,* 53, 166, 169.
[75] , Gary F. Marcus, *The Algebraic Mind: Integrating Connectionism and Cognitive Science,* (Cambridge: MIT, 2001) , 165-6
[76] Gary F. Marcus, "What Developmental Biology Can Tell Us about Innateness," *The Innate Mind: Structure and Contents,* eds. P. Carruthers, Stephen Laurence, and Stephen Stich, (Oxford: Oxford University Press, 2005) 31.

be impossible. But after the protein product of a gene is made, there is not much point in thinking of the gene itself as carrying instructions that guide the effects that protein will have. The cellular machinery that responds to proteins by using them as a guidance cue for axonal growth is highly complex. What effect proteins have in guiding axon growth actually changes as the axon finds its way through the brain. While at one point a certain singal, in the form of a protein in one location of the brain, may cause an axon in another part of the brain to grow towards it. Yet, at a later point in development, that same protein signal may have no effect on axon guidance. There is no simple rule laid down in the genome, but rather many extra-genetic factors are involved.[77]

I take it that Marcus is a rather fair representative of the nativist picture, and his book has been endorsed by Chomsky and Pinker as providing the sort of biological explanation that nativists need. Though we have shifted metaphors from blueprints to instructions, the nativists have clung tightly to the idea that genes play an informational role, and indeed are endowed with the agency to run the developmental show. In the next section, I critique both of these commitments.

Spelling Out Informationism

The first step is to locate the design of the organism in the genome as some sort of information. The design is supposed to be put there by natural selection. Evolutionary psychologists endorse a gene's eye view of evolution itself, so that natural selection acts on genes for which organisms are merely vehicles. There are two different accounts of information, and neither are going to help genes fill this dual role as particles of inheritance and

[77] N. Yamamoto, A. Tamada, and F. Murakami, "Wiring of the brain by a range of guidance cues," *Prog.Neurobiol.* 68.6 (2002), 398.

instructions for development. It is pretty much consensus that the causal account of genetic information is not going to do the job that gene-centered biology needs. The causal account construes information as correlation, or covariation between two systems, the receiver and the sender, that are connected by a channel. Information, in this causal sense, is a correlation, co-variation, or 'systematic causal dependence,' so that we can reliably infer the state of the sender from looking at the state of the receiver, or the other way around. Dark clouds may indicate that it is going to rain, and rain my indicate that there are dark clouds. This relationship goes both ways so that the clouds and the rain both contain information about the other. On this picture, genes are supposed to be the sender, the developmental matrix the channel, and the organism the receiver. Thus, from people who have dyslexia, we can infer that they have the "gene for it" because there is a reliable correlation between the gene and the disorder. This depends on holding everything else constant. But, we could pick out any other reliably occurring causal factor and do the same thing. In this sense, malnourishment would contain information about underdeveloped children because there is a reliable co-variation. [78] This looks to be an unsuitable account of genetic information because it does not pick out genes as unique bearers of information, though this sense of information is helpful in biology because knowing reliable causal covariation is helpful.

The second account of information is intentional or semantic. Thus genes would be informational in the sense of having meaning, or semantic information, which is relatively invariant across contexts, much like statements in a natural language such as English.[79] The intentionality or the representational dimension comes from natural selection, so that a gene represents something by having been selected. Consider Maynard Smith, who claims that "DNA contains information that has been programmed by

[78] *Sex and Death*, 101-3.
[79] Ibid, 104.

natural selection; that this information codes for the amino acid sequence of proteins; that, in a much less well understood sense, the DNA and proteins carry instructions, or a program, for the development of the organism."[80] There is an immediate problem with construing genes as informational. There is no sense in which genes carry information beyond sequences of amino acids that make up proteins, not even in a "much less well understood" way.[81] Worse still, proteins are not directly located in DNA.[82] What amino acid sequence a bit of DNA gets translated into can vary depending on the what else is going on in the cell. The path from DNA to proteins is mediated by RNA. The same sequence of nucleic acids that make up DNA can be transcribed into different RNA sequences, which are then translated into proteins. We cannot therefore identify genes with DNA sequences because these sequences do not have constant effects. There is a serious debate in the philosophical literature about exactly what genes are since there is no well behaved relationship between the structural sequence of DNA, and the functional property of eventually resulting in a protein.[83] But we can put that debate aside, and look at a problem in cell biology where the idea of a code might be useful.

One important problem in cell biology is to understand how the primary structure of proteins, the sequential chain of amino acids, is formed. This answer to this does indeed pick out a unique causal role of genes, that of being templates for RNA which is ultimately a template for the amino acid sequence that makes up proteins. Yet genes do not even control how

[80] Maynard Smith, John, "The Concept of Information in Biology," *Philosophy of Science* 190.
[81] H. F. Nijhout, "Metaphors and the Role of Genes in Development," *BioEssays* 12.9 (1990)
[82] Evelyn Fox Keller, "Beyond the Gene but Beneath the Skin," *Cycles of Contingency: Developmental Systems and Evolution,* eds. Susan Oyama, Paul E Griffiths, and Russell D. Gray, (Cambridge: MIT, 2001) 299.
[83] Sterelny, Kim and Griffiths, Paul E., *Sex and Death: An Introduction to the Philosophy of Biology* 126.

proteins fold, their tertiary structure.[84] Templates are a long way off from instructions or information or programs. Take the example of the templates that are used to press coins. They do not contain instructions for making coins, far less instructions for how coins are to operate in an economy. Moreover, all templates presuppose a lot of machinery to ensure that the template is used in the proper way. They have no agency in themselves. How would someone make that leap of logic from DNA being a template to being a code, information, or a program? Lenny Moss argues that the idea of genetic information and codes is a result of the conflation of two legitimate senses of genes. First, the concept of a gene plays a predictive role in relation to phenotypes, but only in a very restricted class of situations. The sense of information that the predictive gene relies on is the causal account of information and not the semantic one. When discoveries about a gene for something are made, the claim is that the gene plays a predictive role in relation to the phenotype. The second sense of gene as a template on the other hand, "provides possible templates for RNA and protein synthesis but has in itself no determinate relationship to organismal phenotypes."[85] This is the legitimate sense of coding that Godfrey-Smith finds in gene talk. Yet, the idea that genes contain semantic information for traits, code for the phenotype, or are a program for development is a conflation of these two senses of genes. It is to think that genes play a predictive role *because* they contain a representation of the phenotype that causes the development of the organism.

There are many epigenetic interactions that influence gene expression, and there is no way to put your finger on a prime-mover in a causal process that extends indefinitely backwards. Both Nijhout and Evelyn Fox Keller have concluded that there is no reason to view genetic material as constituting a

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[84] , Peter Godfrey-Smith, "Genes and Codes: Lessons from the Philosophy of Mind?," *Where Biology meets Psychology: Philosophical Essays,* ed. Valerie Gray Hardcastle, (Cambridge: MIT, 1999) 315-6.
[85] Lenny Moss, *What Genes Can't Do,* (Cambridge: MIT, 2003) , xiv.

program because genes do not orchestrate the whole developmental process, though obviously genes and their products are necessary for development.[86] There is no monolithic developmental process that can be captured in terms of genetic information or a program. Next I take the case of human brain development, and argue that we should not think of genes as specifying the fine wiring of neurological circuits.

The Evolution and Development of Human Neurology

In this section I mount an argument against the idea that human evolution consisted of the addition of many independent adaptations in the form of cognitive modules, and to further push the spandrel picture. In the last section, I argued against the gene-centered accounts of evolution and development that Evolutionary Psychologists endorse. Development does not proceed from a genetic program, and the idea that genes carry information for the construction of the phenotype falls flat when we look at what genes actually do. They are, given the right context, something like templates for the sequence of amino acids that make up proteins. Here I argue that the general trend of human brain evolution, and the particular developmental trajectory that this created, open the way to the idea that the brain must contain some interesting neurological spandrels.

In just about 9 months of development, the human brain is packed with 100 billion neurons with an average of 250,000 nerve cells being produced every minute, not to mention the 30,000 synapses that form every second for every square centimeter of cortical surface. This is not the end of the story, as by the end of the first year of life, the brain has reached only about 60% of

[86] Nijhout, H. F., "Metaphors and the Role of Genes in Development," *BioEssays* 442, and Keller, Evelyn Fox, "Beyond the Gene but Beneath the Skin," *Cycles of Contingency: Developmental Systems and Evolution* 302.

its adult size.[87] However, genetic information does not instruct or control this process, and that fact is intimately connected with neural plasticity which circumvents the need for genetic instructions or planning ahead.

Evolutionary Psychologists are fond of invoking the metaphor of natural selection as design, and then arguing that any sort of complexity of the organism must be designed, or laid out in advance in the genome. They often compare organisms to artifacts, and argue that something as well designed as a TV set could not arise from randomly throwing together parts. However, this is slightly misleading. Insulated copper wires do not self-connect, not even if you run some electrical current through them. Even if they were to connect, they likely wouldn't produce anything functional. Brains are not much like TV sets, and again we must be careful about arguments from design in artifacts to design in organisms. Our neurology has self-organizing properties that also incorporate massive amounts of non-genetic information, and it is built in the absence of a blueprint specifying each connection. Instead, it is built on the back of a lot, and I mean a lot, of evolution. From this starting point, I make two parallel arguments in this section, that neurological spandrels are likely, and that adaptationism for psychological traits is ruled out by the same process that makes spandrels in the brain possible.

Peter Carruthers has claimed that "the way in which evolution of new systems or structure characteristically operates is by 'bolting on' new special purpose items to the existing repertoire."[88] But did our brains get bigger by bolting on adaptations? It is unlikely. Lewontin argued that for any given character that is going to be the target of selection, it must exhibit quasi-independence. That is, given the all developmental pathways that can lead to that character, there have to be quite a few that that will insulate change from

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[87] , Steven Rose, *The Future of the Brain: the promise and perils of tomorrows neuroscience,* (New York: Oxford University Press, 2005) 63, 117.
[88] Carruthers, Peter, "The Mind Is a System of Modules Shaped by Natural Selection," 10.

negative fitness effects on other characters.[89] Any changes in neurology that were selected for, because of the nature of our neurological development, would likely carry side-consequences. Those side consequences may later acquire functionality.

Human brains have evolved for prolonged infant dependency, and this is reflected in the postnatal continuation of brain growth in humans. Non-human primates have brains that are roughly twice as large as might be predicted for other mammals with the same body size. Terrence Deacon argues that this is not because of accelerated brain growth, or because of intense cognitive selection pressures. Encephalization, or brain expansion relative to body size, proceeds largely by change in developmental timing. Non-human primates start out with smaller bodies, or with a smaller proportion of somatic cells in the developing embryo, which is heavily influenced by homeotic gene expression. From there, their brain and body growth rate is similar to other mammals. "The apparent increase in encephalization in primates is then, more accurately, a decrease in somatization."[90] This means that instead of increasing brain size, primates have a decreased body size because their embryos start out with fewer somatic, or body, cells. The case with humans is quite different. The type of heterochrony, or change in developmental timing, found in humans is a prolonging and delay of our development.[91] There are two components to this. First, gene expression helps to carve up the embryo to allot more neural stem cells and fewer body ones. This phenomenon is known as

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[89] Lewontin, Richard C., "Adaptation," Conceptual Issues in Evolutionary Biology: an anthology, 247.
[90] , Terrence W. Deacon, *The Symbolic Species: the co-evolution of language and the brain,* (New York: W.W. Norton & Company, 1997) , 170.
[91] Michael Mckinney, "Brain Evolution by Stretching the Global Mitotic Clock of Development," *Human Evoltuion through Developmental Change,* ed. McNamara KJ Minugh-Purvis N, (Baltimore: Johns Hopkins University Press, 2002) 173.

predisplacement, or starting out with more.[92] Second, there is a sequential hypermorphosis, or a prolonged duration of stages in brain development, which causes more mitotic cycles of cell division before neurons become specialized for particular functions.[93] For example, the tenfold increase in our cortex area relative to macaques results from extending the period when our founder cells undergo meitosis from 40 to 43 days.[94] Before birth, human brain growth follows the primate growth rate, but it is significantly prolonged postnatally. To grow larger brains, extended postnatal growth is required, given the constraints imposed by the size of the female pelvis.[95] Deacon describes the process as our brains growing as they were in a 1000 pound ape.[96] As a result, human infants are incredibly neotenic in the sense that we born with a relatively immature brain, resulting in prolonged infant dependency and a highly plastic brain. The important point here is that our large brain size is not result of lots of cognitive adaptations for specific innate circuitry, and our cortex is not bigger because more innate information or cognitive modules are packed in there. Perhaps most important though is the neural plasticity that is partially a result of our prolonged brain growth.

This neural plasticity functions to wire up the brain in place of adaptations that specify neural circuitry. Neural plasticity is more than just the ability for the brain to rewire itself as the result of experience, or to recover from injury. Indeed those phenomena are an artifact of the neural developmental process that uses lots of extra-neural and extra-genetic

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[92] Michael Mckinney, "Evolving Behavioral Complexity by Extending Development," *BIOLOGY, BRAINS, AND BEHAVIOR: The Evolution of Human Development,* ed. Sue Taylor Langer and McKinney Parker, (Santa Fe: School of American Research Press, 2000) 26.
[93] Mckinney, Michael, "Brain Evolution by Stretching the Global Mitotic Clock of Development," *Human Evoltuion through Developmental Change*.
[94] , Mckinney, Michael, "Brain Evolution by Stretching the Global Mitotic Clock of Development," *Human Evoltuion through Developmental Change*, 178.
[95] , Elaine Morgan, *The Descent of the Child: Human Evolution from a New Perspective,* (Oxford: Oxford University Press, 1995) 59.
[96] Terrence W. Deacon, "What makes the human brain different?," Annual Review of Anthropology v. 26.(1997).

information to wire the brain.[97] One way to wire up the brain would be to provide genetic instructions so that neurons would know where to go and what to connect with. Instead, neurons are open to a lot of non-genetic information because their functioning, carrying signals, is crucial to how the brain forms. Plasticity allows for neural selectionism, where there is an initial overproduction of neurons, and underspecification of axonal growth and connectivity. Neurons then compete for limited synaptic targets, and unsuccessful connections are later pruned.[98] Stable neural connections are form through selective elimination, rather than through pre-planned instructions. Indeed, planning ahead for the intricate design of the neurological circuits would be extremely difficult, and plasticity and selectionism is a way for the circuitry of the brain to develop with little design information.[99]

Strangely enough, adaptationism for cognitive traits, the idea that "unique human functions based on hypothetical special mutations modifying the local wiring of this or that brain structure," is ruled out by another Darwinian-like process, neural selectionism.[100] Deacon has argued that adaptationism assumes "that the differentiation of each brain structure [is] an independent trait, which would mean that different parts of the brain could be subject to independent evolutionary influences. But this turns out to be unlikely."[101] It would be extremely improbably that the kind of specific neural circuits that would implement unique cognitive modules could either be laid out in advance in the genes or be independent targets of selection.

Neural selectionism operates to accomplish much of our neural wiring. During the early stages of development neurons are over-produced and later

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[97] Deacon, Terrence W., "What makes the human brain different?," *Annual Review of Anthropology* 347.
[98] Ibid, 348.
[99] SS 196
[100] Deacon, Terrence W., *The Symbolic Species: the co-evolution of language and the brain*, 212.
[101] Ibid, 195.

culled. The targets of neurons are largely underdetermined by genetic information, and then there is a process of selective elimination.[102] This process "circumvents the difficulties of planning ahead and allows development to proceed with a minimum of design or regulatory information."[103] The absence of this sort of genetic planning ahead raises serious problems for adaptationists. Neural connections are grossly underspecified by the genes, which are taken by Evolutionary Psychologists to contain the design of the organism, and to be the units of natural selection. This underspecification also allows for a certain creativity in development which increases the likelihood of neurological spandrels with interesting consequences.

Bence Nanay has argued that neural selectionism and the adaptationism of Evolutionary Psychology are not in conflict.[104] Evolutionary Psychology is supposed to explain "why we are born with a certain set of neural connections" and then "selectionist theories serve as explanations of how certain environment effects select among these neural connections." Evolutionary Psychology, in its current manifestation, is certainly not going to explain why we are born with certain connections. Psychological adaptations based on genetic designs require neural circuits based on genetic designs, and selectionism rules out the possibility of the latter. There is an evolutionary and developmental story to be told, but the relevant adaptations are likely to be neural plasticity, a prolonged life history resulting in relatively immature brains at birth, combined with the various adaptations that make having such relatively immature infants possible.

Whether evolution has produced modules in the brain or not, the evolution of the brain has certainly been mosaic. That is, the human brain is not simply a scaled up version of a chimpanzee brain. Some areas increased

102 Ibid, 202.
103 Ibid, 196.
104 , Bence Nanay, "Evolutionary Psychology and the Selectionist Model of Neural Development: A Combined Approach," *Evolution and Cognition* 8.2 (2002), 4.

or decreased relative to the rest of the brain. The prefrontal cortex, according to Terrance Deacon, is about 202% larger in humans that would be expected by mere scaling. This follows the general rule of brain development that 'late makes large,' as the prefrontal cortex is the last developing area of the cortex.[105] The expansion of the human prefrontal cortex is a hotly debated topic. K. Semedeferi et. al. have argued that our prefrontal cortex is not larger than would be expected if we just scaled up a chimpanzee brain. However, they have not measured the same thing as Deacon.[106] Semendeferi (1997) compared the entire frontal cortex, containing the motor, premotor, and prefrontal cortex, to non-frontal cortex. Semendeferi (2002)[107] examined "the overall volume of the frontal cortex, and two of its subdivisions,' the cortex of the precental gyrus, and the remaining frontal cortex on the dorsal, medial and orbital surfaces of the frontal lobe." Deacon thinks that these other nearby motor areas have been reduced, the motor cortex being 35% of what we would expect, and the premotor 77%. Semendeferi's studies carries about as much force as the argument that my body is the same size as my neighbor's because we both live in the same sized apartments.

The relative prefrontalization of human brains is likely to produce some very important spandrels. Deacon argues that because of our enlarged prefrontal cortex, we exhibit front-heavy cognition. The prefrontal cortex underlies goal-directed and intentional behavior, as well as various forms of social cognition. It is also important in novel situations where we cannot rely on habitual behavior.[108] Thus, it could have been the case that our prefrontal

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[105] Mckinney, Michael, "Brain Evolution by Stretching the Global Mitotic Clock of Development," *Human Evoltuion through Developmental Change*, 178.
[106] Preuss has also spotted this slip, though others like Holoway have not.
[107] K. Semendeferi, A. Lu, N. Schenker, and H. Damasio, "Humans and great apes share a large frontal cortex," *Nat Neurosci* 5.3 (2002) , 274.
[108] Earl K Miller and Wael F. Asaad, "The Prefrontal Cortex: conjunction and cognition," *Handbook of Neuropsychology*, ed. J Grafman, Second ed., Elsevier Science, 2002)

cortex was selected for one of these, with the resulting advantages being spandrels.

The conception of modularity offered by Evolutionary Psychology is also at odds with the sort of modularity that the neurosciences predict. The modules that Pinker postulates correspond to overall tasks, which are supposed to correspond to adaptive problems. Neurological modularity is much more fine grained. There, "modules exist at a lower level, at the level of information processing operations which are recruited in various ways in realizing cognitive abilities." William Betechel points to this as a serious problem for Evolutionary Psychologists. When they infer distinct modules from distinct tasks that hominids must have performed, they may just be reifying lower level processing into cognitive modules. It is quite likely that instead of bolting on new modules, evolution made use of already available neurology, and allowed it to be integrated and used for various tasks.[109] Evolutionary Psychology modules then would just be abstractions for talking about non-domain-specific neurology, with the disadvantage of viewing these modules as things that were bolted on, instead of novel uses of available neurology. Churchland and Sejnowski suggest that we think of our neural organization as "networks of networks" that are reciprocally connected and operate in a parallel fashion. Just because some areas of the brain specialize in processing visual information, and some olfactory, it does not mean that we should expect the Evolutionary Psychology kind of modularity.[110]

So why are spandrels likely to arise? Deacon argues that much of our neural organization is not locally or genetically determined. "If a cortical region appears to have changed size or function in the course of evolution it is likely because of a systematic change affecting a number of brain regions

[109] William Betchel, "Modules, Brain Parts, and Evolutionary Psychology," *Evolutionary Psychology: Alternative Approaches*, ed. Stephen J & Frederick Rauscher Scher, Springer, 2002), 219.

[110] Patricia Churchland and Terrence Sejnowski, *The Computational Brain*, (Cambridge, MA: MIT, 1992), 317.

whose connections happen to converge on it."[111] If we think of the brain in terms of networks of networks, the idea would be that how networks in one are of the brain develop would influence how networks in other areas of the brain develop. Our prefrontalization is a result of a phenomenon known as displacement, which entails that "relative increase in certain neuronal populations will tend to translate into the more effective recruitment of afferent and efferent connections in the competition for axons and synapses."[112] Striedter calls this Deacon's rule, that large equals well connected.[113] Our prefrontal cortex recruits more connections to other areas of the brain because of its increase in size. We have a relatively enlarged brain compared to our body, with a disproportionately large prefrontal cortex, and a relatively small peripheral nervous system structures. This causes a cascade in development whereby our prefrontal cortex recruits a greater variety and number of connections because of the global patterns of brain development.

On the spandrel picture, whatever selection pressures drove brain expansion, they could not have done so just by effecting a localized part of neurology that produced a solution only to the 'adaptive problem.' You cannot just increase the relative size of one part of the brain, or the size of the whole brain, without neurological consequences for the rest of the brain. Neurological development rules out the possibility of there being many psychological adaptations that correspond to the sorts of adaptive problems that Evolutionary Psychologists claim we faced. This in itself is good reason for slowing down to take a look at the brain. Perhaps some form of social cognition was the driving force behind the brain expansion in *Homo*. Yet, it is likely that this cast off many neurological spandrels because of the context-sensitive, self-organizational properties of the brain.

[111] *Symbolic Species*, 206.
[112] Ibid, 207.
[113] Georg Striedter, *Principles of Brain Evolution*, (Sunderland: Sinauer, 2005), 350.

I have argued on neurological grounds that because of the integrated nature of neurological development, it is unlikely that natural selection could target specific modules without creating spandrels. Moreover, given the way that genes work in development, and the fact of neural selectionism, it is unlikely that natural selection could target any modules the way that Evolutionary Psychology requires. Next I turn to the pattern of human evolution that is indicated from the archaeological record. There too it seems that a good argument can be made for interesting aspects of human cognition being spandrels.

The Pattern of Hominid Evolution: the Upper Paleolithic Revolution

Cumulative selection is a good thing, but there is a *poverty of time* for cumulative selection to build many novel psychological traits in *Homo*, even if the adaptationist, modular story were neurologically plausible. The hominid line that leads to us diverged from the line that led to chimpanzees some 6-7 million years ago. Aside from the beginnings of bipedalism, not much happens until about 2.5 million years ago when we see the first *Homo* species. When *Homo* does appear, we see a marked increase in brain size, and the beginning of stone tool-making. We can be confident that Homo was the maker of these artifacts because they are found only with *Homo*, and if we find only *Australopithecenes,* we do not find artifacts.[114] After 2. mya, a long period of stasis ensues from 2.5 to 1.7 million years ago. Then we see a spurt in brain growth, followed by another spurt around 500,000 years ago. Anatomically modern humans appear some 160,000 years ago, but we do not see modern behavior for another 100,000 or so years. I will talk more about

[114] David W. Phillipson, *African Archaeology*, Third ed., (New York: Cambridge, 2005).

this biology-behavior gap in the next section, but for now let us consider the issue of time.

Michael Tomasello has argued that "there simply has not been enough time for normal processes of biological evolution involving genetic variation and natural selection to have created, one by one, each of the cognitive skills necessary for modern humans to invent and maintain complex tool-use industries and technologies, complex forms of symbolic communication and representation, and complex social organizations and institutions."[115] We do not see any evidence of a gradual increase in cognitive capacities reflected in artifacts. What we do see are spurts of brain growth and innovation, and then long periods of stasis. It is unlikely that language appears very early in the evolution of *Homo*. It is hard to imagine any species with language that would be content to make the same tools for a million or so years. Theories that posit many mutations and many modules faces the same problem. The pattern of cognitive evolution reflected in artifacts just does not look like a gradual accumulation of cognitive modules.

Tooby and Cosmides posit hundreds or thousands of cognitive adaptations, or modules. Most of these modules perform very isolated tasks. There are no considerations of phylogeny, that is when these traits appeared, whether they are unique to *Homo*, or whether there is there something already in place that might do the job. Descent with modification drops out of the picture entirely. More plausible scenarios posit cognitive adaptations that would integrate or build on what was already in place. For example, Tomasello's proposal for an adaptation (shared attention) for human culture that would have appeared around 200,000 B.P., is able to integrate many of the cognitive phenomena we need to explain, and also accounts better for the pattern that we see in the archaeological record. I make a similar argument in

[115] Michael Tomasello, "The cultural origins of human cognition," *Cambridge, MA, US: Harvard University Press* 1999). vi, 248 pp. (248) 2, See also Derek. Bickerton, "Language in the modular mind? It's a no-brainer!," *Behav.Brain Sci.* 25.6 (2002)

the next chapter. Coupled with a serious poverty of time, there is the serious poverty of genetic control that I explained in the previous section; it may not be the case that mutations could effect the fine wiring that the cognitive adaptations Evolutionary Psychology requires. Now I take a closer look at the so-called Upper Paleolithic revolution and the problems that this poses for adaptationism.

The appearance of anatomically modern *Homo sapiens* is being pushed from 100,000 B.P. backwards, perhaps to 200,000 B.P. White and Asfaw, have recently discovered skeletal remains in Ethiopia that date to 160-154,000 BP.[116] These skulls are morphologically very close to the range displayed anatomically modern *Homo sapiens*. Moreover, a species known as *Homo helmei* (300,000 B.P), which is sometimes regarded as an intermediate between *heidelbergensis* and *sapiens*, has some grounds for being included in *sapiens*.[117] The striking thing about the appearance of anatomically modern *Homo sapiens* is that there is very little change in the archaeological record to suggest that they were behaving any differently from much older hominid species. We have to wait until 60-40,000 B.P, some 100,000 years, before we see the suite of behaviors that we recognize as modern. This change is variously referred to as the Upper Paleolithic Revolution, or the dawn of human culture. The Upper Paleolithic Revolution is a serious challenge to the adaptationist program. We were anatomically modern a full 100,000 years before we started to act modern. The most parsimonious interpretation is that the dawn of human culture was a cultural and not biological change. McBrearty "cognitive capacity for modern behavior was present in the earliest *H. sapiens* but that it took a few hundred thousand

[116] T. D. White, B. Asfaw, D. DeGusta, H. Gilbert, G. D. Richards, G. Suwa, and F. C. Howell, "Pleistocene Homo sapiens from Middle Awash, Ethiopia," *Nature* 423.6941 (2003) 6941.
[117] Sally McBrearty and Alison Brooks, "The Revolution that wasn't: a new interpretation of the origin of modern human behavior," *Journal of Human Evolution* 39.(2000), and Phillipson, David W., African Archaeology 142, 97.

years to put together the package we now recognize as modern behavior."[118] The importance of this gap between biology and behavior is enormous. Up to this point, biology and culture largely changed in step with one another. I first take a look at how adaptationists have dealt with this problem to the extent that they actually have. Then, I turn to the revolution itself. McBrearty has argued that here was no sudden revolution, but rather a series of gradual cultural changes. This lends even more support to the spandrel picture.

For Richard Klein, "the simplest and most economic explanation for the 'dawn' is that it stemmed from a fortuitous mutation that promoted the fully modern brain."[119] This is what I call the genetic inference, tying behavioral modernity to genetic change. Klein accepts that there is a gap between anatomically and behaviorally modern humans, but infers that genetic change, more evolution, must have accompanied this behavioral shift. Pinker realizes that there is something serious at stake here, that there is something striking about the lack of modern behavior in the earliest *Homo sapiens*. He too makes the genetic inference. But he predicts that "the closing date of our biological evolution will creep later, and the opening date of the archaeological revolution will creep earlier, until they coincide."[120] His strategy is to argue that the gap is an illusion created by incomplete evidence.

Both Klein and Pinker are wedded to the genetic inference, and this puts serious constraints on how they interpret the archaeological record. They disagree about whether or not there is a gap between anatomically and behaviorally modern humans, but for both of them the beginning of behaviorally modern humans must coincide with genetic change. The mutation that Klein's theory requires would be very fortuitous, and extremely unlikely. Moreover, it appears that there was no big bang of culture, but

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[118] , C. S. Henshilwood and C. W. Marean, "The origin of modern human behavior," *Curr.Anthropol.* 44.5 (2003), 642.
[119] Richard G Klein and Blake Edgar, The Dawn of Human Culture: A Bold New Theory on What Sparked the "Big Bang" of Human Consciousness, (New York: Wiley, 2002) 270
[120] Pinker, *How the Mind Works*, 205

rather a gradual accumulation and unfolding starting earlier than Klein supposes. This would disconfirm a single mutation at 60,000 years ago.

If very early anatomically modern *Homo sapiens* had the same minds as us, Pinker thinks it is hard to believe that they "sat around for 50,000 years without it dawning on a single one of them that you could carve a tool out of bone, or without a single one feeling the urge to make anything look pretty."[121] But a handful of hominids probably did feel the urge; the changes just didn't take. The biological/behavioral gap is not an illusion, yet the idea that there was a revolution, or a big bang, is now being challenged by archaeological evidence. It appears that there were episodes where hominids ventured into modern behavior sporadically before the whole suite was solidified.

If we drop the genetic assumptions, than we can drop the expectation that there was a big bang. We can say that rather than a revolution, it took modern *sapiens* time to come into its own. Klein and Edgar a lot of weight on symbolic artifacts as unequivocally indicating modern minds, and they put the advent of symbolic artifacts at Enkapune Ya Muto in Kenya, about 40,000 years ago.[122] In 2004, Henshilwood reported shell beads from Blombos Cave, in South Africa, at about 75,000 years ago, pushing things back even further. McBrearty (2000) extensively documents the unfolding of other modern behaviors such as bone tools (100,000 years ago), barbed points (110,000 years ago) and images such as the cave paintings in Europe (35,000 years ago).[123] These were not consolidated and practiced consistently until about 60-40,000 years ago.

The sudden bang model and the genetic inference do fit well together. Yet if there is no sudden bang, then the genetic inference loses all motivation. Instead, "If aspects of modern human culture in Africa were developed by

[121] Pinker, *How the Mind Works*, 203.
[122] Klein, Richard G and Edgar, Blake, *The Dawn of Human Culture: A Bold New Theory on What Sparked the "Big Bang" of Human Consciousness*, 13.
[123] , McBrearty, Sally and Brooks, Alison, "The Revolution that wasn't: a new interpretation of the origin of modern human behavior," *Journal of Human Evolution* 530.

hominids using existing cognitive capacities and transmitted by *cultural rather than genetic processes*, the most likely scenario would be an *accretionary process*, a gradual accumulation of modern behaviors in the African archaeological record."[124] In other words, it is likely that anatomically modern humans appeared around 200,000 years ago, and that it took us time to discover and refine our cognitive spandrels.

Conclusion

In this chapter I made several important arguments. Roughly, what is bad for Evolutionary Psychology is good for the spandrel picture. There is a large gap between anatomically and behaviorally modern humans, a poverty of time for natural selection to have placed many neurological adaptations into the hominid lineage, a poverty of genetic control over the fine wiring of the brain, the prolonged infant dependence and neoteny, neural selection operating to wire up the brain in development, and the likelihood that any neurological adaptations conferred by natural selection would have carried along with them side consequences. In the next chapter I argue the all the facts that make neurological spandrels likely are combined with a particularly potent adaptation, an adaptation that can get the ratchet of culture going and create a synergy between neurology and artifacts

[124] McBrearty, Sally and Brooks, Alison, "The Revolution that wasn't: a new interpretation of the origin of modern human behavior," *Journal of Human Evolution* 456, My emphasis.

Chapter 3: Decoupled Cognition and Artifacts

Introduction

What Evolutionary Psychology gets right is the critique of Blank Slate empiricism. What it gets wrong is just about everything else. The hope that a massively modular and innate mind, combined with computationalism, could display the kind of flexibility characteristic of human cognition, and that adaptationism would supply the evolutionary explanation of where it came from should be shaken by the criticisms that I have laid out. The flexibility of human cognition cannot arise from battalions of modules or the Swiss Army Knife model of the mind, and the Stone Age Mind thesis should itself be a relic. In this chapter, I turn first to phylogeny instead of hypothetical problems that hominids might have faced in the Pleistocene. There is a very striking difference between human and chimpanzee cognition. Humans from 9 months after birth are able to engage in shared attentional activities with other people. It is implausible that shared attention is a cognitive module in the sense that Evolutionary Psychologists use the word, and shared attention is one of the key abilities that underlies other uniquely human cognitive achievements like language. There was no problem for which shared attention was the solution.

In this chapter I make the argument that artifacts drove human decoupled cognition, and using and making artifacts requires decoupled cognition. The two work in synergy, and when combined with shared attentional abilities, human culture took off. I recommend that we view many other human cognitive abilities as spandrels. Human cognition is evolutionarily unique in that it always involves artifacts, they are what we think with in an important sense. Our cognitive development is heavily artifactually scaffolded, and infants are prepared to take advantage of this with their shared attentional abilities.

First I lay out the relationship between human cognition and artifacts, and then I introduce the idea of decoupled cognition. Then I canvas shared attention, and the unique form of social learning it supports, imitation. After that, I turn to language and argue that it is best viewed as a cognitive artifact. Finally, I turn to the issue of cognitive flexibility and the gap between where natural selection left off and modern human cognition began, and argue that my picture better explains both of these than Evolutionary Psychology does.

Decoupled Cognition and Artifacts

In this section, I make two proposals about human cognition. First, human cognition always involves artifacts. Second, I introduce what I call decoupled cognition, which is an idea I take over from Kim Sterelny. He instead uses the phrase decoupled representation, but I avoid this terminology because I don't think that decoupled representations are representations at all. I also want to add to Sterelny's account an evolutionary scenario about how our cognition became decoupled. But first I have an argument to make about artifacts.

I doubt that any evolutionist would have a problem with the claim that the difference between human language and animal communication systems is a difference in kind, and not quantity. Human languages are not just more complicated vervet call systems, chimpanzee gestures, or bee dances. There is nothing anti-evolutionary about this point. This difference was not always obvious, and it is due in part to the theoretical attention given to language, and the tools developed to characterize its properties. I want to make the same argument about artifacts, that they are uniquely human. Since 2.5 million years ago, artifacts have marked the difference between the genus

Homo and our close relatives such as the chimpanzees. Ecologically we are dependent upon artifacts, but we are cognitively dependent upon them too. There would be no human cognition apart from artifacts. On my conception, language, tools, and folk psychology are all artifacts, things that we have made. There is a point in grouping all of these things together, even though, for instance, there is really no analogue of syntax in tool use. Before I go into my account, I want to present a recent trend in the philosophy of cognition that has began to take artifacts seriously.

Cognitive Artifacts

The relation between artifacts and cognition has recently been taken up by philosophers who hold embodied and extended views of the mind. They have pushed the idea that artifacts can *augment* cognition, which they surely can. Yet little attention is paid to the evolutionary origins of this uniquely human ability. The typical examples chosen are artifacts such as calculators, maps, and writing. Edwin Hutchins defines cognitive artifacts as those things "made for the purpose of aiding, enhancing, or improving cognition." [125] For example, we may invent rules of thumb to facilitate our cognition. Turn to the right to make it tight, to the left to make it loose, is a good rule of thumb for using a screw driver. Other examples might include recipes and instruction manuals. These artifacts presuppose sophisticated cognitive performances, both in making and using them. Rules of thumb are generated by those who are experienced with certain artifactual tasks, and they can be then passed on to aid novices. Rigidly following a rule of thumb or recipe is not characteristic of human cognition. Any rule of practice is unlikely to apply in all cases. Persistently turning a screw clockwise to tighten

[125] Edwin Hutchins, "Cognitive Artifacts," *The MIT Encyclopedia of the Cognitive Sciences*, eds. Robert A Wilson and Frank C. Keil, (Cambridge, MA: MIT, 1999) 126.

it is no good if the screw is a left-hand thread. We are also good at figuring out what steps in a recipe to omit depending on contextual factors. It is impossible to plan everything ahead, or to specify all relevant instructions and how to carry them out in advance. Indeed, any sort of planning ahead only helps if you can modify things on the fly.

We have the kind of cognition that allows us to structure our world, and then to cognitively exploit that structure. For example, you might organize the books on your shelf alphabetically by author or instead group books by subject, or by publication date. Each kind of organization will lend itself to different kinds of searches. If you are writing a chapter on human evolution, it might be helpful to have all of the relevant books grouped together. On the other hand, if you are writing a paper on Richard Rorty, who has written on several subjects, it might be better to have all of his books grouped together. "The key event in the evolution of the modern mind," claims Steve Mithen, "appears to be when humans began to *extend* their mind by exploiting not just language, but also material culture and their social structures, as a means of *augmenting* the mental capacities delivered by the brain alone."[126] However, I doubt that augmentation is the right way to think of the relationship between human cognition and artifacts. They do no augment some sort of bare human cognition that could exist apart from them, but are instead the stuff human cognition is made of. The first stone tools did not augment our ability to cut and process carcasses any more than hammers augment the ability of the bare human hand to drive nails into wood. To make this argument, I am going to have to take a closer look at what artifacts are.

Andy Clark makes two hypotheses about what is biologically unique about human cognition, what underpins our ability to make and exploit artifacts. He cites the neural plasticity and our prolonged childhood that I

[126] Steven Mithen, "Mind, Brain, and Material Culture: an Archaeological Perspective," *Evolution and the Human Mind*, eds. P. Carruthers and A Chamberlain, (Cambridge: Cambridge University Press, 2000) 207, my emphasis.

mentioned in Chapter 2. Clark then wonders, "since no other species on the planet builds as varied, complex and open-ended designer environments as we do ... what is it that allowed this process to get off the ground in our species in such a spectacular way?"[127] This is what I propose to explore. Our neural plasticity and extended childhood are two key elements that make our artifactual cognition possible, but the third key is our uniquely human ability to share attention with another person to an object. This emerges at around 9 months of age, and it is an adaptation that allows development to take advantage of neural plasticity, extended childhood, and an artifactual environment. The trend in embodied, embedded, and extended philosophies of cognition is to argue against Cartesian assumptions, that the best and most important examples of cognition are off-line episodes of abstract reasoning. Instead, embodied views of cognition emphasize fluent organism-environment couplings. We do indeed exhibit unique cognition-environment couplings, yet part of what makes this possible is the distinct sense in which our cognition is decoupled. Part of what makes our cognition different from the rest of primates is our ability to use information in broad-banded, non-task-specific ways.

I want a different starting point than the embodied and extended mind philosophers, who take artifacts to be ways of augmenting human cognition. Unfortunately, philosophers have not usually put much thought into artifacts, and I am going to take over the concept of artifacts that Barry Allen has put forward. Artifacts, for Allen, are effects of performance under all their descriptions, including byproducts. Thus, the first stone tools would be artifacts as well as the debris created during their production. Performance is purposive, goal directed, and admits of evaluation. Species typical behaviors are not performance, and performance is never algorithmic. Even though chimpanzees have a long learning curve when it comes to their proto-tool

[127] Andy Clark, "Reasons, robots and the extended mind," *Mind & Language* 16.2 (2001), 136.

use, no chimpanzee performs very much better than any other. Chimpanzees do not discriminate between ill and well-formed movements, or evaluate the execution of their actions.[128] It is impossible to have just one artifact, as artifacts only exist in an economy.[129] It takes an artifact to make an artifact, and nowhere do we find humans with something that is not made. Other animals may modify their environments, but they do not make anything, and there is no performance that they take an evaluative stance towards.

Primatologist Christophe Boesch observes that some populations of chimpanzees use "naturally occurring hammers" to open nuts.[130] But Raymond Tallis points out an "absolutely pivotal difference" between human tools and chimpanzee proto-tools. Human tools are always *made*.[131] And in this making is where I locate the origins of decoupled cognition. Chimpanzees will select appropriate sized rocks for cracking nuts, but they will not make a better stone tool for the job, or use their "hammers" for anything else. If you suggest that chimpanzees don't really use tools, you will face the primatologist's charge of defining tools in such a way that apes don't use them, because obviously all wild chimpanzee populations have them.[132]

There is evidence for regional diversity in chimpanzee proto-tool use. At Gombe, chimpanzees fish for termites with small sticks. In other parts of Africa, chimpanzees use longer sticks, which are more efficient, to fish for termites and they then remove from the stick by the handful. This does not amount to tool use, nor does it amount to culture. The regional difference in fishing strategies is likely explained by chimpanzees discovering the

[128] David Premack, "Pedagogy and Aesthetics as Sources of Culture," *Handbook of Cognitive Neuroscience,* ed. Michael Gazzaniga, (New York: Plenum Press, 1984) 20.
[129] Barry Allen, *Knowledge and Civilization*, (Boulder, Colorado: Westview Press, 2004) 64 A good argument can be made that there is no *thing* that is not an artifact. I do not think that I need to push this line of thought for my argument here.
[130] Christophe Boesch, "Is Culture a Golden Barrier Between Human and Chimpanzee?," *Evolutionary Anthropology* 12.(2003), 84.
[131] Raymond Tallis, *The Hand: A Philosophical Inquiry into Human Being,* (Edinburgh: Edinburgh University Press, 2003) ,226.
[132] Franz de Waal, *The Ape and the Sushi Master: Cultural Reflections by a Primatologist,* (New York: Basic Books, 2001) 243-5.

affordances of objects, and not by learning a technique. One of the most recent reports of chimpanzee proto-tool use indicated that in the Congo basin, chimpanzees make use of two different sticks to fish for termites. Chimpanzees with first use larger and thicker sticks to puncture the termite mound, and then use a thinner stick to fish for termites.[133]

One of the more impressive examples of proto-tool use comes from New Caledonia crows. They will snap twigs off trees in such a way as to leave a slight hook on one end of the twig that they then use to pry food out of crevices.[134] Yet, this seems to be an example of strong instinct and species-typical behavior. Juvenile crows raised without adults present, and never having seen any sort of demonstration, will modify twigs as early as 68 days after birth. This puts a damper on analogies between their modified twigs and human tools, to say nothing of the idea that the 'have culture'.[135]

There are at least five differences between proto-tool use and what *Homo* has always done. First, humans make their tools, which already requires a whole economy of artifacts. Chimpanzees modify twigs with their hands, but it already took a tool, an artifact, to make the first stone tools. Second, the modifications are relatively stimulus bound, and constrained perceptually. Trimming twigs to fish for termites is guided by the immediate perceptual situation, which is not the case for making stone flakes as I later explain. Third, all proto-tool use involves very narrow-banded response. Chimpanzees do not generalize their proto-tool use to new tasks that are functionally similar, nor to the innovation of a new artifact form. Fourth, proto-tools are not social items. They are made and used by individuals, who never attempt to teach others, or to share or trade tools, or to modify a tool with

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[133] Crickette Sanz, Dave Morgan, and Steve Gulick, "New Insights into Chimpanzees, Tools, and Termites from the Congo Basin," *The American Naturalist* 164.5 (2004), 568.
[134] Gavin R. Hunt and Russell D. Gray, "The Crafting of Hook Tools by Wild New Caledonia Crows," *Proceedings of the Royal Society of London* 271.(2004).
[135] Ben Kenward, Alex Weir, Christian Rutz, and Alex Kacelnik, "Tool manufacture by naive juvenile crows," *Nature* 433.(2005), 121.

anticipation of how another might use it. Other animals do not practice making or using their proto-tools, nor is there any dimension of performance or evaluation. Fifth, there is no accumulation and improvement of proto-tool repertoire. The twigs that chimpanzees use from generation to generation stay the same and there is no cultural accumulation.

Both the Blank Slate and Evolutionary Psychology share a representationalist view of culture and cognition, they only disagree about where representations primarily come from. I do not offer artifacts as a definition of human culture, though all human cultures have them. We have been with artifacts much longer than with any sort of symbolic culture, moreover any cultural symbols or representations are things that humans have made, all artifacts too. In the next section I explain how artifacts and decoupled cognition go together.

Decoupled Cognition

Our performance with recent and sophisticated cognitive artifacts requires decoupled cognition. However, I want to explain the origins of decoupled cognition in the hominid lineage in terms of their practices of making artifacts. I am borrowing the idea of decoupled cognition from what Kim Sterelny calls decoupled representations. For an organism to represent an aspect of its environment in a decoupled way, it needs to do two things. First, it needs to robustly track that aspect of the environment, and second, it needs to be able to respond in a broad-banded way to the information it tracks. Decoupled representations are supposed to be "internal states that track aspects of our world, but which do not have the function of controlling particular behaviors." Thus, they are supposed to be belief-like. Having the information that it is going to rain next Tuesday is potentially relevant to many actions. Yet, it does not drive any specific behavior.[136]

Organisms can track features of their environment in a variety of ways. More robust forms of tracking will not be stimulus bound. One might loosely track the attentional state of conspecifics by locking onto one relatively stable cue such as frontal aspect, or the direction the upper body faces. This seems to be what chimpanzees do to the extent they do understand what other chimpanzees can see. However, this says nothing about how chimpanzees conceptualize the attentional state of conspecifics, and it seems to be the case that they cannot exploit what others see in a robust way. Daniel Povinelli has presented convincing experimental evidence that attentional states are rather opaque to chimpanzees. When given a choice, chimpanzees will gesture for food from the human trainer who is facing them but has her eyes covered, instead of the trainer who's torso is turned away but looking over her shoulder with her eyes visible.[137] Chimpanzees seem to be locked into using the one cue, frontal aspect, and have a difficult time using eyes alone to calibrate their tracking or response. On the other hand, in competitive tasks, chimpanzees do seem to understand what conspecifics see. Subordinate chimpanzees will preferentially take food that another dominant chimpanzee cannot see, and they keep track of which dominants know where food is and which ones do not.[138] This is a much easier cognitive problem than co-operating, or coordinating actions, which chimpanzees do not do in the wild.

One particular kind of tracking that I claim is especially important is the ability to categorize the world in functional or instrumental terms. Raymond Tallis has argued that this ability evolutionarily arose from our uniquely human

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[136] Sterelny, Kim and Griffiths, Paul E., *Sex and Death: An Introduction to the Philosophy of Biology*, 34.
[137] , Daniel J. Povinelli, Jesse M. Bering, and Steve Giambrone, "Toward a Science of Other Minds: Escaping the Argument by Analogy," *Cognitive Science* 24.3 (2000), 525.
[138] Josep Call, "Chimpanzee Social Cognition," *Trends in Cognitive Sciences* 5.9 (2001), 390.

hands, our "ability to exert a deliberate choice between manipulative strategies."[139] We are able to think in terms of what artifacts can possibly do, and each artifact "embodies new possibility in a permanent way."[140] We apply this sort of functional thinking to our actions, and to those of others. We perceive behavior in intentional terms, as actions that are goal directed, and that can be more or less successful. Other animals do not appear to take any interest in their proto-tools after they are done with them, nor in what conspecifics do with their proto-tools. They are not possibilities for further use or improvement. Functional cognition is a kind of intentional cognition, where we extend goals that agents have to the functionality of artifacts, possibilities of how they might be recruited.

Another step in the complexity of tracking is organizing concepts not just in relation to the world, but also in relation to each other. Language allows us to put our

concepts into hierarchical and combinatorial relations with one another. So

that can be a

dog, or a mammal, or Rover, or man's best friend. I doubt that non-linguistic animals enjoy the ability to think in this way, though of course they do think. Humans are uniquely purposeful and sensitive to norms. We constantly reflect on our success and failure, and use this reflection to drive practice in the future. And our artifacts are "human purpose made visible, offset for the natural world," which makes human purpose itself an artifact that we can cognitively reflect on.[141]

The other half of decoupled cognition is broad-banded response, which would be a liability without robust forms of tracking. If you cannot check cues against one another, then there would be little to guide different responses. Broad-banded response is made possible by gaining some cognitive distance

[139] Tallis, Raymond, *The Hand: A Philosophical Inquiry into Human Being*, 38-9.
[140] Ibid, 233.
[141] Ibid, 231.

between tracking and behavioral outcomes. The central case of broad-banded response I have in mind is the advent of stone tools. A major shift in broad-banded response was facilitated by our shared attentional abilities, which gave our cognition a strong social turn. The proto-tool use of chimpanzees is an example of narrow-banded cognition. Though they can fish for termites, and crack nuts with rocks, they do not generalize these behaviors to other potential food items. Nor do they innovate new proto-tool forms, or take these proto-tools up into social life.

Sterelny argues that using cognitive artifacts presupposes decoupled representations. For example, we can put sharp blades to use in a number of ways. Understanding what makes blades good tools for cutting, and decoupling that information from one specific task, say butchering meat, allows us to employ blades in a variety of contexts. Chimpanzees probably do not represent information about what makes rocks effective for cracking nuts in a decoupled way so that they could transfer the principles to cracking other objects open. Alternatively, they may not track their environment in terms of "interesting things that can be cracked open." Tracking and response breadth go hand in hand. Sterelny does not locate the origins of decoupled representation in our ability to make and use artifacts. Yet, this is precisely where we should be looking. Artifacts, existing only in social economies, by their nature cut across social and technical domains. Artifactual cognition cannot be constrained to the kind of domains the modules of Evolutionary Psychology would require. The evolution of decoupled cognition in hominids just is the evolution of artifactual cognition; artifacts are what we respond broad-bandedly with. After the Upper Paleolithic, the route human artifactual cognition has taken is not just broad-banded, but open-ended. The argument I make is that artifacts and decoupled cognition present an alternative conception of human cognitive evolution and development that avoids both Blank Slate empiricism and the Stone Age Mind hypothesis of Evolutionary Psychology.

Shared Attention

So far I have two ideas on the table. Human cognition is both decoupled and artifactual. In this section, I argue that shared attention, the ability to understand one another as intentional agents who purse goals and choose means to reach them, is uniquely human and makes possible much of our artifactual cognition. Shared attention also enables a particular form of social learning, imitation, which acts as a ratchet for human culture. The ability to understand others as goal directed would have facilitated a particular broad-banded response, namely, collaboration. The ability to collaborate, to share a common goal, and pursue different but complementary actions to achieve it, is much more cognitively demanding than tracking cheaters or defectors.

Human infants do not just respond in reflexive, rigid or stereotyped ways to environmental stimuli, and as they gain control of their muscles they do more than just aimlessly flail around. Their explorations are goal directed and purposeful; infants are very interested in looking at their hands and they will make efforts bring them into view. As one psychologist puts it, "Perception, cognition and motivation develop at the interface between neural processes and actions."[142] These behaviors are neither innate, in the sense of being antecedently laid down in the genes, nor somehow learned from experience. As the infant's neurology develops in conjunction with the explorations of the infant, new motor control is gained, and more possibilities for exploration emerge. Infants gain visual predictive ability for moving

[142] , Claes von Hofsten, "An Action Perspective on Motor Development," *Trends in Cognitive Sciences* 8.6 (2004), 267.

objects that become temporarily occluded, which emerges around 17 weeks after birth. When watching an object moving left to right behind a barrier, infants begin to visually predict where the object will reappear.[143] We are not born with a fully functioning visual system, rather it develops along side enviromental interactions. Neurology, motor control, and perception develop along with the infant's explorations. Moreover, human infants are highly motivated to explore the environment in new ways as these abilities develop.

In the first 8 months of life human infants engage in dyadic interactions, such as face to face communication with their parents, or learning to reach for and track objects. Far from being passive and soaking up experience like a sponge, infants actively engage with the world, their own bodies, and others from early on after birth. At 9 months, human development starts down a new pathway, what some have called a revolution. At this point triadic activities emerge, where the infant interacts with objects and the parent at the same time. This triadic activity is called shared or joint attention. At this point infants coordinate their attentional focus with the attentional focus of others. Thus instead of just reaching for objects, infants will attempt to share attention *with* an adult *to* an object of interest, and attempt to get the adult to facilitate their own goal of grasping the object.[144] Shared attention is the cognitive ability that allows us to do what Donald Davidson called triangulation, so that each agent "is interacting simultaneously with the world and with the other agent."[145]

With the 9 month revolution, argues Michael Tomasello, infants begin to understand others as intentional agents who have goals and plans. Moreover they begin to understand that agents have different means to

[143] Ibid, 270.
[144] Philippe Rochat and Tricia Striano, "Social-Cognitive Development in the First Year of Life," *Early Social Cognition: Understanding Others in the First Months of Life,* ed. Philippe Rochat, (Mahwah, NJ: Lawrence Erlbaum Associates, 1999) 24.
[145] Donald Davidson, *Subjective, Intersubjective, Objective,* (Oxford: Clarendon Press, 2001) 128.

achieve their goals, and that they have an ability to choose between these means. This is in contrast to the understanding of others as animated or self-propelled, which seems to be the highest level of understanding that non-human animals are capable of, including chimpanzees.[146] The development of shared attentional abilities is likely scaffolded by adults who interpret the actions of infants as intentional by engaging in joint attentional activities with them. Infants will reach for toys and combine this with a looking back and forth with the adult, and will often persist until the adult complies.[147] Lack of shared attentional abilities is predictive of autism, and in children with various other developmental delays lack of shared attention is a predictor for their delayed vocabulary growth linguistic development in the second year of life.

There has been no convincing demonstration of shared attention outside of humans. Communication in chimpanzees is a dyadic process. Chimpanzees occasionally ritualize gestures with one another, like human infants who may learn to raise their arms if they want to be picked up. However, chimpanzees do not understand these gestures as bi-directional so that A can use the gesture to elicit behavior from B, and B can likewise use it on A, nor are the gestures shared with other members of the group. There is no shared attention involved, no attempts to direct each other's attention to an outside object.[148] It may be surprising to find that chimpanzees do not engage in the shared attentional behavior of pointing to objects, and further they do not seem to understand pointing as an intentional act to have their attention directed to an object. There has been only one report of an instance

[146] Michael Tomasello, "The human adaptation for culture," *Annual Review of Anthropology* 28, 1999, pp. 509-529.(1999), 513.
[147] Yvonne Bruinsma, Robert L. Koegel, and Lynn Kern Koegel, "Joint Attention and Children With Autism: A Review of the Literature," *Mental Retardation & Developmental Disabilities Research Reviews* 10.(2004), 170.
[148] Tomasello, Michael, "The human adaptation for culture," *Annual Review of Anthropology* 522.

of pointing in 40 years of field observation.[149] Daniel Povinelli has conducted a series of experiments to test what chimpanzees understand about pointing. When an experimenter points to a box with food, chimpanzees simply choose the box closest to the experimenter's hand. If the trial is set up so that the boxes are equidistant from the experimenter's pointing hand, chimpanzees perform no better than chance in selecting the correct box. In contrast, 26 month old humans get it right on first trial.[150]

I want to put forward shared attention as the crucial adaptation that anatomically modern humans would have been outfitted with. During the temporal gap between anatomically and behaviorally modern humans, I envision a process of discovery taking place where humans began to recruit more artifacts into their practices. In contrast to the proposals of Evolutionary Psychology, I am not proposing a special purpose cognitive module in their sense of the word. What would the domain for shared attention be? What would it be encapsulated with respect to? We can share attention with anyone to nearly anything else, and there are probably no cues or information we cannot use when sharing attention. Linguistic symbols may even allow people to share attention to the not-present and the non-actual. There would have been many things that shared attention would be good for, and again unlike Evolutionary Psychology I am not committed to shared attention reflecting the structure of a specific adaptive problem. If I had to guess, I would say that shared attention made the biggest difference in collaborative activities, indeed by making them possible in a new way. Collaborating with others, where we share a common goal, and perform different but complementary activities to achieve it, is a significantly harder problem than competing with one another. Of course, at once we can share

[149] Daniel J. Povinelli, Jesse M. Bering, and Steve Giambrone, "Chimpanzees' "Pointing": Another Error fo the Argument by Analogy?," *Pointing: Where Language, Culture, and Cognition Meet,* ed. Sotaro Kita, (Mahwah, NJ: Lawrence Elrbaum, 2003) 41. Goodall and Nishida have not reported pointing, only Vea & Sabater-Pi (1998) have according to Povinelli.
[150] Ibid, 60-1.

attention and understand others as having goals, that would also ramp-up the demands of competitive tasks.

Shared attention allowed us to cognitively recruit artifacts and others in a broad-banded way, and it presents a new form of tracking. We begin to track ourselves and others in terms of goals, purposes, and intentions. We can modify what others track by directing their attention to it. This opens up the possibility of facilitating my goals by using people as well as artifacts as intermediaries. Instead of trying to make something to hold the painting in place while I check to see if it is level, I can ask you to do one task while I do the other. The difference between anatomically modern and behaviorally modern humans has been the expansion and increasing density of our social-artifact-cognitive relationships. We can bring in more people, more intricate artifacts in more ways. In the next section I outline one particular shared attentional ability, imitation, that drives a specific kind of social learning. Following that, I turn to language as another shared-attentional activity.

Imitation

Imitation needs to be carefully distinguished from other forms of social learning. It is first of all a more *social* form of learning, and it cognitively presupposes shared attentional abilities. There has been quite a bit of debate about exactly how imitation works, or what mechanisms underlie it. I make a small suggestion about how to think about this mechanism in terms of decoupled cognition. Tomasello argues that imitation requires "reproducing an instrumental act understood intentionally."[151] Thus to imitate we need to understand others as having goals, and we need to be able to understand actions as purposeful. In imitative learning, the subject learns not just

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[151] Tomasello, Michael, "The human adaptation for culture," *Annual Review of Anthropology* 514.

something about the environment or objects, nor do they learn some new motor pattern. Instead, by understanding the other person as goal-directed, the imitator attends both to what the demonstrator is doing, or trying to do, and *how* she is doing it.

By contrast, in mimicking, the 'learner' reproduce the body movements of the 'teacher.' Brass and Heyes rather unhelpfully label this as imitation, which they define as "copying body movement."[152] Shortly after birth infants will stick out their tongue in response to seeing an adult stick out his or her tongue. In cases like this, there is no separation between behavioral strategy and goal. The same goes for chimpanzees who have been trained to copy the body movements of demonstrators, such as raising two arms, or patting their stomach. With emulation learning, the subject learns about objects and what can be done with them. This is likely to be what happens when chimpanzees learn to fish for termites or crack nuts. By seeing others, they learn things about the world, such as that nuts can be cracked with rocks, but they do not learn a technique for accomplishing it. In 1953 an 18 month old Japanese macaque named Imo stumbled upon the trick of taking sand-covered sweet potatoes into the water and washing them off. Some members of the troop did eventually pick up on this strategy. However, it took a long time. In three years, less than half of the troop caught on, and as more monkeys learned, the rate of spread did not increase.[153]

It really is worth the trouble to distinguish imitation from these other two forms of social learning. Mimicking and emulation to do not lead to cultural accumulation, and in both cases you either learn some body movement or something about the world, but not both. When human infants imitate, they are able to make two crucial distinctions. First, because they understand others as having goals, they are able to make the distinction between what

[152] Marcel Brass and Cecilia Heyes, "Imitation: Is Cognitive Neuroscience Solving the Correspondence Problem?," *Trends in Cognitive Sciences* 9.10 (2005), 490.
[153] Tomasello, Michael, "The human adaptation for culture," *Annual Review of Anthropology* 519.

someone tries to do and what they actually end up accomplishing. Second, they understand the difference between the goal and the behavioral means to achieve the goal. There is no such gap in mimicking.[154] If 14 month old infants see a demonstrator turn on a light with her head, they will only reproduce this behavior strategy if the demonstrator has her hands free. If her hands are otherwise occupied, holding a parcel say, infants will choose to use their hands to turn the light on.[155] Chimpanzees do not pick up the behavioral strategies of demonstrators, but rather just attempt to produce the actual result. It is not clear that if a chimpanzee sees a demonstrator unsuccessfully perform a task that it would even bother to try to reproduce any results or figure out what the affordances of the objects were. If children see a demonstrator attempt a task and fail, they will reproduce what the demonstrator intended to do, what his or her goal was. There have been many experiments with human children that illustrate their imitative abilities. Children will imitate unusual means to achieve a goal, and they will reproduce what the demonstrator tried to do when he or she fails. Actions that the demonstrator marks with a "Whoops!" will be omitted when children have a turn at the task. If they see adults try to pull a toy apart unsuccessfully, children will attempt to pull it apart when given a turn, indicating that they understand what the adult's goal was.

So what is the value of imitative learning, and by what mechanisms it is accomplished? I suggest that imitative learning is especially important when learning techniques is important. Human performance is purposeful and open to evaluation in terms of failure and success, as well as by aesthetic standards. Among the many ways to accomplish a task, there are often 'right'

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[154] Michael Tomasello and Malinda Carpenter, "Intention Reading and Imitative Learning," *Perspectives on Imitation: From Neuroscience to Social Science,* eds. Susan Hurley and Nick Chater, vol. Volume 2: Imitation, Human Development, and Culture, (Cambridge, MA: MIT, 2005) 136-7.

[155] Michael Tomasello, Malinda Carpenter, Josep Call, Tanya Behne, and Henrike Moll, "Understanding and sharing intentions: The Origins of cultural cognition," *Behav.Brain Sci.* 28.(2005), 679.

ones that are evaluated in terms of social standards, 'the way we do things around here,' or aesthetic and perceptual standards, achieving a certain look or form. Moreover, technique is much more important to how we use artifacts than it is to the proto-tool use of non-human animals. Using a twig to fish for termites or a rock to crack a nut requires good motor coordination, and though it may take chimpanzees a long time to learn how to accomplish either of these tasks, attending to exactly how others bring about the result is not important.

There is likely no simple mechanism for imitation. The ability to imitate presupposes an intentional understanding of others. Some researchers pose the problem of how a correspondence can be achieved between motor or behavior programs when B watches A perform an action.[156] Whiten explains, "we might say that B has to get the program for behavior out of A's head."[157] This is a misleading way to think about how imitative learning works. No two swings of a hammer are ever exactly the same, and the idea that action works by the execution of a 'program for behavior' is suspect. The subject needs to first understand what about the technique was intentional and what was accidental. Some accidental aspects of the action might just be mistakes. Yet a deeper sense of accidental applies to those aspects of action that are not functionally required. To understand this, the subject needs some experience effecting change in the world, and to be able to understand what she has done in intentional terms.

The Evolutionary Origins of Imitation

So when did imitation start operating in the *Homo* lineage? The ability to make the so-called Oldowan stone tools that appeared about 2.5 million

[156] Brass, Marcel and Heyes, Cecilia, "Imitation: Is Cognitive Neuroscience Solving the Correspondence Problem?," *Trends in Cognitive Sciences*
[157] Andrew Whiten and R. Ham, "On the Nature and Evolution of of Imitation in the Animal Kingdom," *Advances in the Study of Animal Behavior* 21.(1992), 271.

years ago is well beyond the ability of non-human primates, both biomechanically and cognitively. The striking thing about the first stone tools is the incredibly long period of stasis. The Oldowan tradition lasted virtually unchanged for 900,000 years. Around 1.6 million years ago, so-called Acheulean handaxes appear. We then have to wait another 1.4 million years, until 250,000 years ago, to see new blade technologies. Variation in artifact form either rarely dawned on the hominid stone tool makers, or any variation was suppressed. If imitation was operating, we might expect to see a ratchet effect, where culture is not only preserved from one generation to the next, but also improved upon. For instance, given the kind of cognitive sophistication that imitation presupposes, it is hard to imagine that hominids would not have occasionally innovated new forms. Imitation requires functional cognition, understanding agents and by extension artifacts, as having purposes. From there, it should not be a huge leap to being able to innovate at least a few new forms for different intended results. Further, if these earlier hominids had the ability to imitate, then some occasional artifactual variations should be preserved and have spread. But this is not the pattern that we see. On the other hand, it is hard to understand how hominids could have made stone tools without the ability to imitate.

Biomechanically, the stone tool makers needed to deliver hard, focused blows without crunching their fingers in the process. Hard-hammer percussion, probably the most common method for producing flakes in the Oldowan, involves holding a core stone in the left hand, and swinging a hammer stone at it with the right (assuming you are right handed). The idea is to fracture off an overhanging part of the stone, producing sharp edges on both the flake and the core. To do so, you need to visually search for good places to strike, and you have to strike the core stone at a sharp angle. Good knappers are able to work the core so that each removal of a flake sets up another flaking opportunity. Mastering a technique like this would demand practice without immediate payoff and require the cognitive ability to anticipate what sharp flakes and cores are good for. Chimpanzees don't sit around practicing trimming twigs, and they don't need too. Moreover, early stone tools were sometimes transported for miles. This would have required more foresight and planning than we see in chimpanzees.[158]

Nicholas Toth, an expert in the manufacture of stone tools, tried to teach Kanzi the superstar bonobo (*Pan paniscus*) the hard-hammer percussion technique. The results indicate that the biomechanical and cognitive aspects are beyond the abilities of non-human primates. Chimpanzees (and bonobos) lack the appropriate physiology from the shoulder all the way down to the finger tips. Cognitively, Kanzi did not grasp the mechanics of the task, especially searching for acute angles that would produce a sharp flake. Kanzi's preferred method is to throw the rocks against a hard floor. When the experimenters placed Kanzi in a padded room, he innovated another strategy, placing the core stone on the floor in front of him and throwing the hammerstone at it. If the researchers present Kanzi with a blunted flake, he will try unsuccessfully to cut with it, with no attempt to sharpen or modify the edge.[159] Kanzi does not practice flaking without a reward present, and the cognitive demands are probably too great for him to overcome.

The first stone tools required a new technical intelligence, but I am reluctant to suppose that imitative learning was a factor at this point. My guess is that shared attention and imitative learning did not emerge much before anatomically modern *Homo sapiens*. Stone-tool making was probably learned the hard way, by observing the utility of sharp flakes that other

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158 Kathy D Schick and Nicholas Toth, *Making Silent Stones Speak: Human Evolution and the Dawn of Technology,* (New York: Simon and Schuster, 1993) 139.

159 Kathy D Schick, Nicholas Toth, Gary Garufi, Sue Savage-Rumbaugh, Duane Rumbaugh, and Rose Sevcik, "Continuing Investigations into the Stone Tool-Making and Tool-using Capabilities of a Bonobo (Pan paniscus)," *Journal of Archaeological Science* 26.(1999), 822, 827.

hominids produced, and having to figure out the mechanics mostly for oneself. Our technical intelligence is now well integrated with our social and aesthetic cognition, and has been since at least 50,000 years ago. So, I am not suggesting that there is a module for making or using tools, and I doubt there could be. It is likely that hominids used their stone tools in broad-banded ways, exploiting blades and cores for a variety of purposes. Understanding how to produce sharp blades probably went hand-in-hand with an ability to exploit them for multiple tasks. The technical-social interface made possible with shared attention was not the coming together of two modular capacities. Rather, shared attention would have facilitated new technical possibilities. Next, I turn to the social-symbolic artifact that shared attention and imitation underpin, namely language.

Language

Language may be the pinnacle of decoupled cognition, the ultimate cognitive artifact. Yet there is a strong trend in cognitive science to see language as merely a system for communication, having little or no cognitive benefit itself. In part this is because of strong trend to subscribe to an innate language of thought, or mentalese. If cognition is computation, then mentalese is the representational format that our brain computes with. Generative grammarians such as Chomsky and Pinker suppose that innate grammatical knowledge, if there is any, is represented in propositional form, and thus we must have an innate representational system to couch the innate grammatical knowledge in. There is however good reason suppose that we do not have an innate language of thought, and that supposing we do is an attribution error. I return to the topic of mentalese and computation in the following section. In this section, I offer an account of language as a cognitive artifact and extend my account of decoupled cognition.

Perhaps the most prominent question in the language evolution literature is this: is grammar a biological adaptation? Adaptationist accounts of language claim that it has to be, and they draw on the work of Chomsky that is supposed to show that we have an innate Language Acquisition Device, which would contain represented grammatical rules that specify the universals of syntax, which is required for constructing sentences out of words. In short, Chomsky claims that infants are outfitted with an innate Universal Grammar, and adaptationists use the idea of Universal Grammar as a 'design' premise in their arguments. These innate, universal, represented rules are supposed to be in our brain in advance of any experience with language, and linguistic input just acts as a trigger to set parameters such as whether the infant is hearing a language where subjects precede verbs or follow them. If Universal Grammar is innate, which Chomsky understands to mean 'genetically determined,' then why not argue that it was selected too? Pinker makes just that argument, that Universal Grammar is genetically determined and was thus selected, and that Universal Grammar must be an adaptation because of how well designed it appears.

It is possible to respect the complexity of grammatical structure, and the importance of syntax without buying into the nativism of Chomsky or the adaptationism of Pinker. It is improbable that hominids had full blown, syntactic language until about 50,000 years ago. This appears to be about the time that what we recognize as modern human behavior was first consolidated and practiced consistently. This leaves about 150,000 between the appearance of anatomically and behaviorally modern humans. The consolidation of modern human behavior, as I argued in Chapter 2, was not itself a genetic or biological event, it was a cultural one. And so too might language have been.

Fully syntactic language may have been preceded by what Derek Bickerton has called proto-language. Contrary to a recent proposal by

Bickerton, protolanguage would have required shared attentional abilities, and it is not likely that they arose much before 200,000 years ago.[160] Proto-language is basically language minus syntax. This would require using non-linguistic cues to figure out the communicational intention of your interlocutor. Communication would consist of attempts to direct the attention of others using a small lexicon and a lot of context-bound gesticulation. Bickerton has also argued persuasively against gradualist accounts of syntactic evolution. There is just nothing in between proto-language and language, it is not possible to have just a bit of syntax. Thus it seems that two options are open to the adaptationist. First, argue that anatomically modern humans around 200,000 years ago had the innate adaptation for syntax, and the biology-behavior gap is an illusion. This does not seem to be a promising strategy. Alternatively, adaptationists might try to argue that one miraculous adaptation for syntax appeared about 50,000 years ago along with the rest of behavioral modernity. I do not see why that idea would be more appealing than the claim that language is a spandrel. One genetic mutation that could wire-in the kind of syntax-specific circuits that Pinker would require? Unlikely.

Humans brains are certainly outfitted with special neurological equipment for syntactic processing. We can accept this point and at the same time deny that we have an innate Universal Grammar that consists of represented rules that are triggered by input. Syntax in my sense is a processing ability that you could not learn to have, much as chimpanzees cannot learn to have shared attention. There is really nothing about language that could be learned by standard associationist mechanisms. That is something that Chomsky was right about. There is no question that human infants are prepared to learn language, and it is likely that language acquisition is over-determined by many factors. Human language has two unique characteristics that set it apart from the systems of communication

[160] D. Bickerton, "Language first, then shared intentionality, then a beneficent spiral," *Behav.Brain Sci.* 28.5 (2005), 691.

that other species use; it has a symbolic and syntactic dimension. These characteristics allow language to be non-stimulus bound and productive. The rule in language is to say something new. Aside from a few stock utterances like "Hi, how are you?" most of language is producing and understanding completely novel sentences that no one has ever heard or uttered before. Thus language is categorically different from the systems of communication that other animals use.

Vervet monkeys, for example, make at least six distinct alarm calls, each to signal the presence of ecologically significant predators such as snakes, eagles, and leopards. These alarm calls are not the equivalent of words, nor are they holophrastic utterances, or one word sentences.[161] Trying to pin linguistic content on these calls is misguided. It is more likely that alarm calls work as signals in an indexical fashion. One thing is an index of another when the first, the alarm call, reliably signals the presence of something else. Thus smoke would be an index of, or indicate the presence of fire. Vervets cannot help but produce these calls, and the members of their troop cannot help but produce the stereotypical responses, such as running up a tree. What vervets lack is the ability to use the cues in a non-stimulus bound way, to say something like "Maybe that was a leopard?" or "Did you see a leopard?" Vervet calls are also not productive; you cannot string together a leopard call and a snake call to mean "there goes a leopard-snake."

Symbols, on the other hand, are inherently combinatorial and the reference of any symbol is determined by the mappings and possibilities of combinations with other symbols. Indices only work as long as the association between indicat*or* and indicat*ed* is maintained. If the causal co-variation between fire and smoke were altered such that there were many other things in the environment caused smoke, we could no longer use

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[161] Derek. Bickerton, *Language and Species,* (Chicago, Illinois: University of Chicago Press, 1990) 12.

smoke as a reliable indicator of fire. Symbols are not stimulus bound, and we can use them to refer to the distant in space and time and even to the impossible. Restoring the relation between symbols and syntax is one way to resist the conclusions of Chomsky, who thinks that word learning and grammar learning are two separate problems.

Syntax is the only likely candidate for a module, and this fits with the idea of an innate Universal Grammar. Chomsky makes the distinction between linguistic *competence*, "the speaker-hearer's knowledge of his language," and linguistic *performance*, the "actual use of language in concrete situations."[162] Competence so understood is essentially a generative grammar, or rules that specify how to produce new, well-formed sentences from the lexicon. This is one aspect of linguistic creativity. If anything is a module, it is likely this competence. Linguistic performance cannot possibly be a module. There could be no module that dictates how to respond appropriately in a conversational context. Anything can be relevant, and thus a performance module could not be encapsulated, and the only possible domain for such a module would be 'things to talk about' which is about non-domain specific as it is possible to get.

Terrence Deacon has made a fresh proposal about the evolution of language. Brains evolve on a geological time scale, while languages are able to change must faster in historical time. Deacon argues that language itself would have been under a strong selection pressure to be learnable by children. If linguistic structures do not fit the guesses of children, the structures will not be passed on. Children would then easily learn language because language itself has evolved to be learnable by children.[163] The structure and universals of language would then reflect those selection

[162] Noam Chomsky, *Aspects of the Theory of Syntax,* (Cambridge, MA: MIT, 1965) 4.
[163] Deacon, Terrence W., *The Symbolic Species: the co-evolution of language and the brain,*109.

pressures, as well as communicative and symbolic constraints rather, than being "prefigured in the brain like frozen evolutionary accidents."[164]

Learning symbols and learning grammar are not really two separate learning problems, and chimpanzees seem to have nearly as much trouble with symbol learning as they do with syntax. It is usually assumed that infants learn words by mapping them onto pre-existing or innate concepts, and grammar is triggered by linguistic input. The alternative is not a general learning or general intelligence hypothesis. There are some very specific things particular to human children and to the symbol learning problem. First, shared attentional abilities would create the necessary triadic envelope for language to take place in. Second, the problem of symbolic learning is to use symbol-symbol mappings and possibilities of combination to determine how symbols point to non-symbols. The symbolic reference of the word 'dog' is not achieved by some causal correlation or association of the word with actual dogs. Instead, reference is a function of how the symbol 'dog' enters into relationships with other symbols. The same is true for learning a new symbol. When someone learns a new word, she fits it into a whole symbolic scheme. The constraints on producing symbolic reference might produce some of the universal patterns across language, which would cast more doubt onto the idea that we are born with an innate, represented Universal Grammar. Recursion, which is part of the syntactic mechanism that makes language productive, is partly defined by patterns of possible symbolic substitutions under the constrain of preserving reference. Phrases are defined recursively, that is in terms of themselves. In sentences, phrases can be substituted for words. The 'He' in "He went to the store' can be replaced by 'My neighbor Bob' to get 'My neighbor Bob went to the store.' There are also possibilities of replacement where phrases can be embedded within phrases. So from 'The boy kicked the dog' we can construct 'The boy

[164] , Deacon, Terrence W., *The Symbolic Species: the co-evolution of language and the brain*, 116.

who went to the store kicked the dog.'[165] Thus the preservation of reference would act as a universal constraint across languages and contribute to their common structural and syntactic properties.

I now have enough pieces in place to back up my assertions that human cognition always involves artifacts, and that artifacts are what we think with. Even if grammar is a biological adaptation, which I doubt, that would not mean that language is not an artifact. Without appropriate environmental scaffolding, children will not learn a language. The environment is thoroughly artifactual, and language is an effect of these artifacts, and hence and artifact too. Language, as a cognitive artifact, "alters the nature of the computational tasks involved in various kinds of problem solving."[166] What language does, I suggest, is give us productive, symbolic, decoupled cognition across the board. Language is the only means to symbolic conceptual abilities. Our public symbols decouple cognition from perception. I doubt that chimpanzees could think about the respects in which yesterday was like today, or how tomorrow might be different. To do so requires being able to uncoupled oneself from the present and reflect on the past or future, which cannot be directly perceptually tracked. Rudolf Arnheim has suggested that language "assists the mind in stabilizing and preserving intellectual entities," by providing "a clear-cut, distinct sign for each type."[167] Thus language can distinguish between what might be perceptually nearly indistinguishable, we can give words to these differences, and use these symbols to direct our attention. Here I work through a few examples that illustrate how human cognition intimately involves artifacts.

Numerals (and numbers unless you are a Platonist) are of course artifacts too. It is very difficult to perform arithmetical operations with Roman

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[165] , Terrence W. Deacon, "Universal Grammar and Semiotic Constraints," *Language Evolution,* eds. Morten Christiansen and Simon Kirby, Oxford University Press, 2003) 127.
[166] Andy Clark, *Being There: Putting Brain, Body, and World Together Again*, (Cambridge, MA: MIT, 1997) ,193.
[167] Rudolf Arnheim, *Visual Thinking,* (Berkeley, CA: University of California Press, 1969) 236.

numerals, but much easier with Arabic ones. Multiplying 752 by 811 is very difficult to do 'in ones head,' but it becomes much easier if we write it on paper, especially using Arabic numerals. Writing the problem down reduces the load on working memory, making it easier to keep track of which digits we have calculated and what carries over to the next step.[168] It is even easier if, instead of writing "752 x 811" we write:

752
<u>811</u>

By manipulating the problem space we have transformed a more difficult problem into an easier perceptual problem. Thus we can first calculate

752
<u>1</u>
752

and then,

752
<u>10</u>
7520

and then,

752

[168] D. E. Rumelhart, P. Smolensky, J. L. McClelland, and G. E. Hinton, "Schemata and Sequential Thought Processes in PDP Models," *Parallel Distributed Processing: Explorations in the Microstructure of Cognition,* vol. Volume 2: Psychological and Biological Models, (Cambridge, MA: MIT, 1986) 45.

800
601600

and then add the results,

752
7520
601600
609872

Our writing the numbers down is itself part of the problem solving, just as moving and rotating pieces of a jigsaw puzzle is often part of how we determine which pieces will fit together. Later, our ability to multiply numbers 'in our head' depends on our learning to "manipulate a mental model in the same way as we originally manipulated the world."[169] There is neuro-imagining evidence that our off-line process draw on the same sensory-motor regions of our brains that we use on-line.[170] Being able to visualize the steps in calculations is an example of decoupled cognition, because it requires being able to manipulate and move around intellectual items in our mind's eye.

There are many examples of the role of artifacts in cognition, and Eugene Ferguson has provided many examples from the field of engineering, such as development of technical diagrams and models. More everyday examples include how engineers use thinking sketches to "focus and guide nonverbal thinking." The demands on working memory would be too high to fully plan out something like a bridge in one's head, and then just go build it.

[169] Clark, Andy, *Being There: Putting Brain, Body, and World Together Again*, 61, 63.
[170] , Lawrence W. Barsalou, "Perceptual Symbol Systems," *Behavioral & Brain Sciences* 22.(1999), 579

Talking sketches, where engineers sketch back and forth on the fly, sometimes even taking the pencil out from one another's hand, is not just a form of communication but also of cognition.[171] It requires being sensitive to what the other person is doing and responding in a way so as to clarify your ideas to her, and probably also to yourself.

But does human cognition always involve artifacts? Imagine lying in the dark before sleep and planning what you will do tomorrow. No pencils or paper, so what artifacts could you be cognitively recruiting? First, I would suggest that language, the ubiquitous cognitive artifact, fuels much of our off-line, decoupled cognition. Syntax enables long trains of thought, and the non-stimulus-bound nature of symbols allows us to construct linguistic cues that we can later enroll on-line, such as "don't forget my wallet." Second, our off-line visual cognition, where I might picture in my mind's eye how to solve the problem of packing my apartment into a moving van, depends on decoupled concepts, which are certainly artifacts. Dennett wonders if a chimpanzee could imagine "a man climbing a up a rope with a plastic garbage-pail over his head?"[172] All of these items are familiar to chimpanzees, the question is could they decouple them from perception and mentally put them together again in this arrangement? My account of decoupled cognition suggests that the answer is no. Just as chimpanzees do not generalize their tool use, share attention, point, or practice for better performance tomorrow, they also do not imagine how things could possibly be.

As Arnheim suggested, chimpanzee thought is "limited to coping with directly given situations."[173] Trimming the leaves off of a twig so that it is suitable for termite fishing is a problem that is directly perceptually given to primates. Looking for an acute angle to strike a rock at to produce a sharp flake, in contrast, involves the ability to visualize into the future. Humans with

[171] Eugene S. Ferguson, *Engineering and the Mind's Eye,* (Cambridge, MA: MIT, 1992) 97
[172] Daniel Dennett, *Darwin's Dangerous Idea,* (New York: Simon and Schuster, 1995) 372.
[173] Arnheim, Rudolf, *Visual Thinking*, 228.

their decoupled cognitive abilities, can engage in what Bickerton calls off-line thinking, the ability for people to "work out problems that do not immediately confront them."[174] To do so, we need decoupled cognitive systems like language and our decoupled visual concepts that provide the organism with non-stimulus-bound items to respond broad-bandedly with.

Our cognitive equipment is artifactual, and moreover, our cognitive problems are artifacts too, such as getting downtown, or playing chess. These problems are effects of other artifacts. Without our artifacts, these problems simply would not exist. Even more broadly, our cognitive success depends on our organized artifactual infrastructure such as bus routes, clocks, cities and our work environments. In this section, I have argued that language is best viewed as a cognitive artifact. The orthodoxy in cognitive science is a communicative view of language, where our real thinking is done in a language of thought. In the next section, I turn to decoupled cognition and the computationalist orthodoxy in cognitive science.

Decoupled Cognition, Representationalism, and Computationalism

Taking a representation-first view of cognition is unhelpful in many respects. Artifacts are not the reflection of pre-formed inner representations, and there are no algorithms for making or using artifacts. Decoupled representations, claims Sterelny, are supposed to be "internal states that track aspects of our world, but which do not have the function of controlling particular behaviors."[175] At one point, Sterelny makes an incautious move in claiming that, "Intelligent, adaptive behavior depends on the existence of an

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[174] , Derek. Bickerton, *Language and Human Behavior,* (Seattle: University of Washington Press, 1995) 59.
[175] Sterelny, Kim, *Thought in a Hostile World: The Evolution of Human Cognition*,17.

accurate internal model of the world."[176] However, I think that the view of decoupled representations he works out goes a long way towards undermining representationalist theories of cognition. One important facet of decoupled cognition that I have highlighted is the ability to share attention. The understanding of other people as having goals and exerting a choice over the means to achieve them is evolutionarily and developmentally prior to our ability to attribute sentential attitudes and beliefs. This latter ability is called Theory of Mind, which is part of the cognitive underpinning of folk psychology, or the practice of interpreting others as having beliefs and desires. With language and later folk psychology we gain a tool, something that we have made to facilitate social interactions, in part by tracking others in terms of what sentences they would likely bet are true. However, linguistic content and sentences prove to be an unhelpful and unfriendly format for our brain to compute in. In this section, I argue against the brand of computationalism that supposes cognition is explained by the inner traffic of a language of thought. Evolutionary Psychology has gladly taken over from cognitive science the idea that cognitive success is representational success. What Evolutionary Psychology adds is the thesis that our minds are massively modular, packed with algorithms and innate ideas specific to problems hominids are supposed to have faced in the Pleistocene. I argue that decoupled cognition and artifacts together undermine any prospects of computationalism, the thesis that thinking is symbol crunching in some internal code.

The philosopher Robert Cummins has been a strong critic of the Representational Theory of Mind in nearly all of its current manifestations. Philosophers have focused more on theories of content that attempt to pin the right meaning on the symbol, rather than telling us exactly why representations are supposed to be good things for cognition. I do not want

[176] , Sterelny, Kim, *Thought in a Hostile World: The Evolution of Human Cognition*, 17, my emphasis.

to review all of the current theories of content. Instead, I want to talk about two theories that are closely related to decoupled cognition. First, I want to distance the idea of decoupled cognition from informational theories of content in the style of Fred Dretske and Jerry Fodor. Theories of this type attempt to be naturalistic, that is give a theory of content without invoking semantic concepts like truth. Instead, information is understood to be a subtle form of causal co-variation. Sterelny is sometimes quite close to such naturalistic theories, and I want to suggest that this is an unwise move. Second, I want to add to the criticism of the language of thought hypothesis, which constitutes the computationalist assumption of Evolutionary Psychology. One way cognition could be decoupled would be if our brains were outfitted with a language of thought, an innate computational medium that is decoupled in the way that spoken (and written) language is. I argue that both causal / informational theories of content and the language of thought hypothesis are not going to carry us very far in understanding how decoupled cognition works.

Causal theories of representation are designed to supply a theory of content for the language of thought, and they are supposed to be a naturalistic way of understanding content in terms of information. Concepts are supposed to carry information about the properties they causally co-vary with. These theories postulate two layers. First, there are detection mechanisms that enable the organism to detect certain features of the world. So far so good for decoupled cognition. Second, there are supposed to be unstructured, atomistic indicators that get 'lit up' when the detection mechanism registers an instance of the type they are supposed to track. This is where I suggest we should get off the informational bandwagon. These indicators are supposed to be like the symbols in a natural language, bearing no structural relationship to what they carry information about.[177] Causal theories of content are atomistic, such that the content of an indicator is determined independently of the content of any other indicator. Just like the word 'dog' doesn't bear any structural resemblance to dogs, symbols in the language of thought are not going to tell you much about the things they refer to. What is appealing about the language of thought is roughly the same thing that is appealing about language. You can use a finite stock of symbols plus a syntax for putting them together to come up with an infinite number of sentences. However, I argued that symbolic reference is a function of symbol-symbol relationships, and thus is not atomistic. Representation is a normative concept, so what an indicator recruited into a representational role represents is what it is *supposed* to indicate.[178] The function of indicators is sometimes conferred by us, like the gas gauge in a car. In what Dretske calls natural systems, the function is supposed to be conferred by learning history or evolution. No one has yet worked out a satisfactory account of informational semantics that will pin the right meaning on the right internal state. Moreover, indicators are just like vervet calls and not much like linguistic symbols. No one has offered an account of how indicators can be decoupled and given combinatorial properties.

My broader concern with causal theories of representation is that detection mechanisms are doing all of the hard cognitive work, and there is no convincing explanation of why having inner arbitrary symbols is going to fuel cognitive success. Sterelny sometimes walks a fine line, too close to informational theories of content. It is easy to slide from talking about how we track aspects of our environment to talking about the indicator content of brain states that is set up via causal co-variation. Yet, from the perspective of decoupled cognition, causal theories of content do not distinguish between

[177] , Fred Dretske, *Explaining Behavior: Reasons in a World of Causes,* (Cambridge, MA: MIT, 1988) 59.
[178] Dretske, Fred, *Explaining Behavior: Reasons in a World of Causes*, 59.

multiple ways of tracking, nor do they take broad-banded response into account. Chimpanzees may in some circumstances loosely track the visual states of conspecifics, and if they do so, causal theories may successfully attribute internal, information bearing states to them. In fact, these theories will attribute exactly the same contentful state to humans who track visual attention more robustly, and are able to use that tracking to drive a greater breadth of response. As a consequence, indicator theories have a hard time explaining differences between human and non-human cognition. The idea of a decoupled indicator is nearly a conceptual contradiction. Perception always involves unifying unruly manifestations, and there is nothing like a common sensory pattern for dogs and only dogs.[179] To become cognitively locked onto any property requires sophisticated detection mechanisms. It is unclear why having an indicator light up will help cognition. The hope is that indicators can be enrolled in a language of thought, and to this I now turn.

Folk psychology, our practice of attributing beliefs and desires to each other and ourselves, is the starting point for the language of thought hypothesis. This practice of interpretation is holistic and operates under a rationality constraint. Thus, there are no mere beliefs, that is internal, intrinsically propositionally contentful states. As Donald Davidson puts it, "if we cannot find a way to interpret the utterances and other behavior of a creature as revealing a set of beliefs largely consistent and true by our own standards, we have no reason to count that creature as rational, as having beliefs, or as saying anything."[180] We cannot ask first what an organism believes and then try to sort out whether the beliefs make any sense. Non-human animals do not have what is called a theory of mind, or the ability to attribute contentful mental states to one another, and presumably to

[179], Paul Churchland and Patricia Churchland, "Fodor and Lepore: State-Space Semantics and Meaning Holism," *The Churchlands and Their Critics,* ed. Robert N. McCauley, (Cambridge, MA: Blackwell, 1996) 274.
[180] Donald Davidson, *Inquiries into Truth and Interpretation,* (Oxford: Clarendon Press, 1984) 137.

themselves. In humans, theory of mind skills emerge around 4 years of age when children are first able to pass false belief tasks.

Is folk psychology an attempt at describing what Godfrey-Smith calls the wiring facts, or "real features of how agents are wired and how they are connected to the world"?[181] Supporters of the language of thought hypothesis argue that it is such an attempt, and a largely successful one. Eliminativists such as Stich and Chuchland 'believe' that folk psychology will be replaced by a better cognitive science. [182] I suggest that folk psychology is an artifact, a kind of interpersonal social calculus, and so-called theory of mind abilities are a spandrel. Rather than an attempt at describing our inner wiring, I agree with Dennett that intentional interpretation is a "vernacular social technology, a craft."[183] I like Wilfrid Sellars' myth of Jones, who invents the idea of thought and beliefs as inner episodes and then models them on "*overt verbal behavior itself.*"[184] However, language of thought advocates infer from the success of our folk psychological predictions that our brain must traffic in inner sentences. What Hutchins calls the attribution problem, is rampant in cognitive science. The error is to take properties of a whole organism-environment cognitive system, and to locate them in the head of the individual. The computationalist hypotheses modeled on public language and folk psychology mistakenly attribute to the organism an innate language of thought that resides in the brain. My suggestion about Universal Grammar was that it too is an attribution error, locating the origin of common structural properties of languages that arise from symbol and communication constraints in innate represented rules. In chapter 2, I discussed the case of

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[181] Peter Godfrey-Smith, "On Folk Psychology and Mental Representation," *Representation in Mind: New Approaches to Mental Representation,* eds. Hugh Clapin, Phillip Staines, and Peter Slezak, (Oxford: Elsevier Science, 2004) ,148.
[182] Stephen Stich, *From Folk Psychology to Cognitive Science: The Case Against Belief,* (Cambridge, MA: MIT, 1983) 221,
[183] Daniel C. Dennett, *The Intentional Stance,* (Cambridge, MA: MIT, 1987) 46.
[184] Wilfrid Sellars, *Science, Perception and Reality,* (London: Routledge & Kegan Paul, 1963) 186.

genetic information. By taking a close look at what genes actually do, the idea of a genetic code for the phenotype become problematic. I advocate the same stance towards our neurology. It plays a unique causal role in cognition much like genes play a unique causal role in development, however I doubt that its representing anything, especially folk psychological content, is the right handle by which to pick up the problems of cognition.

The language of thought hypothesis is also funded by what Gilbert Ryle called the intellectualist myth, which claims that cognition in the first case and most of the time involves explicit representing, following instructions or recipes, and chains of deduction and inference.[185] Jerry Fodor thinks that "one of the most striking facts about the cognitive mind," is the "frequent similarity between trains of thought and *arguments*."[186] Thus cognition is supposed to be Sherlock Holmesian and also carried out in the same format that we use to interpret each other. The only amendment to these claims that Evolutionary Psychology makes is that the norm of cognition is not what Sherlock Holmes would consider to be a good argument, but instead what would have been adaptive way back in the Pleistocene.

The appeal of computationalism comes largely from the appeal of the idea that we have an inner, language-like code. Yet, there is a prima facie difficulty with this idea. Spoken or written language depends on a process of interpreting symbols that bear no resemblance to what they are about, and are thus in a sense arbitrary. If symbols in the language of thought need to be interpreted, then you will need to postulate another inner code to do the interpreting, or we will have to postulate a non-interpretive process. Either way, the idea of an inner code seems like just a metaphor.[187] As we have seen, naturalistic philosophers favor indicator theories, which take even more

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[185] Dennett, Daniel C., *The Intentional Stance*, 213.
[186] , Jerry Fodor, *Psychosemantics: The Problem of Meaning in the Philosophy of Mind,* (Cambridge, MA: MIT, 1987) 13.
[187] Robert A Wilson, *Boundaries of the Mind: The Individual in the Fragile Sciences,* (Cambridge: Cambridge University Press, 2004) 149.

out of the idea that we have an inner symbolic code. If we think of cognition as being generated by instructions or recipes for action couched in a language of thought, it is not clear that we have explained anything. Instructions rely on the idea of being *understood*. As Robert Cummins puts it, "reading a recipe is a sophisticated cognitive performance of the very sort that representationalists want to explain by appeal to the capacity to represent."[188] Let me quote Fodor's lively story of how we tie our shoes, which illustrates the relationship between the language of thought and our actions:

> There is a little man who lives in one's head. The little man keeps a library. When one acts upon the intention to tie one's shoes, the little man fetches down a volume entitled Tying One's Shoes. The volume says such things as: "Take the left free end of the shoelace in the left hand. Cross the left free end of the shoelace over the right free end of the shoelace..., etc.
>
> When the little man reads the instruction `take the left free end of the shoelace in the left hand', he pushes a button on a control panel. The button is marked `take the left free end of a shoelace in the left hand.' When depressed, it activates a series of wheels, cogs, levers, and hydraulic mechanisms. As a causal consequence of the functioning of these mechanisms, one's left hand comes to seize the appropriate end of the shoelace.[189]

[188] Robert Cummins, *Representations, Targets, and Attitudes*, (Cambridge, MA: MIT, 1996) 103-4.
[189] Jerry Fodor, "The Appeal to Tacit Knowledge in Psychological Explanation," *Representations,* ed. Jerry Fodor, (Cambridge, MA: MIT, 1981) 63-4.

This is an unabashedly intellectualist account of how we tie our shoes. Now what exactly happens after a button is pressed? That is perhaps the complicated part of cognition, coordinating motor and perceptual systems that execute instructions couched in the language of thought. The assumption is that after sentence in the language of thought, the rest is all just dumb mechanical execution. But this cannot be right. After we give instructions for building a chair to a carpenter, the rest is anything but unskilled mechanical execution. Moreover, tying one's shoes is as close as we will get to algorithmic behavior. No one has yet written a set of instructions for more complicated artifactual performance, say how to write a symphony.

Robert Cummins argues that there are only two things that arbitrary mental symbols can do for the computationalist in the explanation of action. First, they can trigger procedures, and second, they can cue stored knowledge, which at some point cannot consist of just more arbitrary symbols.[190] I adapt these points from Cummins to re-tell Fodor's story.

In Fodor's story, when you token a mental sentence 'I shall tie my shoes now', that sentence acts as a trigger to call up all of the procedures stored in the Tying One's Shoes volume. This volume is full of mental sentences which are instructions. An instruction might trigger a procedure that executes it, or it might cue stored knowledge. Even the first step in Fodor's shoe tying story needs to be further decomposed. You first need to locate or detect the left free end of the shoelace. To do this, 'locate the left free end of the shoelace' needs to *cue* your stored knowledge about how to do so. The mental symbol 'shoelace' does not itself tell you what shoelaces look like, or where to look for them. At some point, your stored knowledge cannot be another mental sentence. Now suppose that you have finally located the left free end of your shoelace. Then some complex of detection mechanisms might cause the relevant indicators to be tokened that would

[190] Cummins, Robert, *Representations, Targets, and Attitudes*, 70.

then need to somehow lead to the inference in your mentalese that 'the left free end of the shoelace has been located,' which will then *trigger* a procedure for reaching and grasping. Again, 'grasp it with your left hand' will cue your stored knowledge about how to do so, and when you detect that is complete, some complex mental process will again token a mental sentence to that effect which will result in moving onto the next step, and so on.

In performing these actions, your stored knowledge and your detection mechanisms are doing all of the work. Just like a recipe for baking a cake, you need to know how to carry out the instructions, and it cannot be language-like instructions all the way down. To commit oneself to the idea that the language of though is really code-like takes away any explanatory appeal of postulating a language of thought in the first place. Indeed, it is not clear that there is any account of mental representation that successfully elucidates what the value of these representations would be. Computers are of course examples of the "possibility of storing and 'acting on' something without really understanding it."[191] But what is downstream of the language of thought is anything but stupid mechanical execution. Finding the left free end of your shoelace is an enormously complex task. I would bet that we are much better at the task if we can watch someone demonstrate the process or perhaps looking some good diagrams than we are at learning to tie our shoes from a set of linguistic instructions. Whatever instructions we have, as Tallis writes, "very few actions are absolutely specifiable."[192] At some point our sensual knowledge must range beyond what can be specified in diagrams or instructions.[193] Unless, on pain of regress, we are to have instructions for carrying out instructions, at some point we must have a wealth of non-linguistic knowledge.

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191 , Dennett, Daniel C., *The Intentional Stance*, 213, 220.
192 , Tallis, Raymond, *The Hand: A Philosophical Inquiry into Human Being*, 66.
193 , Ferguson, Eugene S., *Engineering and the Mind's Eye*, 58.

The problem with having our actions primarily guided by explicit representations, especially linguistic ones, is that representations are too brittle, and of no help when it comes to generalizing to novel situations, or responding broad-bandedly. Imagine two sets of instructions, one for opening pop-top bottles with a bottle opener, and one for using a key to open a door. It is possible to use your house key to open the pop-top of a beverage bottle. What in either set of instructions is going to help you figure out how to do so? Instead, we rely on analogical thinking, done mostly in perceptual and motor terms. Language is productive, so we can potentially put together an infinite number of sentences. But the principles of successful action are not the same as those principles that give language its productive ability.

The other problems with computationalism can also neatly be stated within the decoupled cognition framework. What is called the infraverbal catastrophe comes back with even more bite. Non-human animals either have a language of thought, or they don't. If computationalists claim that the language of thought is unique to humans, then it would be an evolutionary bolt from the blue. No computationalist wants to claim that, because computation is supposed to explain animal cognition too. If it is claimed that non-human animals do have a language of thought, there is simply no evidence for it.[194] Human cognition is more decoupled than non-human cognition in that we can track aspects of the environment in more robust ways, and we can respond in a broad-banded fashion. Postulating a language of thought is not going to explain either of those differences, nor the similarities between human and non-human cognition. The language of thought can only make use of indicators, and these are fueled by detection mechanisms. To explain broad-banded response, advocates of the language of thought hypothesis are going to have to explain why, if both share a

[194], Patricia Churchland and Terrence Sejnowski, "Neural Representation and Neural Computation," *Philosophical Perspectives, Vol.4, Action Theory and Philosophy of Mind* (1990).

language of thought, only humans are able to use it to drive broad-banded response.

Even Jerry Fodor, the father of the language of thought hypothesis, thinks that computationalism can't really be true. Tooby and Cosmides agree with Fodor that the only prospect of saving computationalism comes from massive modularity, which could offer a possible escape from the so-called frame problem.[195] If there is no way in advance to throw a frame around what information is relevant to solving a problem or making a decision, combinatorial explosion ensues. Without the relevant encapsulation, coming up with an answer becomes computationally intractable. However, we have good reason to think that our minds are not massively modular in the sense that Evolutionary Psychology supposes they are. I offer a diagnosis of the failings of computationalism, though it is not entirely a new one; it is probably impossible to account for the apparently non-algorithmic aspects of performance in terms of algorithms operating over representations. Fodor points to a specific case, that of belief-fixation, or figuring out what to believe given a new piece of information and your background beliefs. The problem is that there is just no algorithm or rule for deciding how to adjust your beliefs.

If someone tells me that they just heard Steven Harper was assassinated, there is no rule for figuring out what belief to adopt. Is the person trust-worthy? Is the source the person heard it from trustworthy? Are there any recent events that would make it more probable? Perhaps Harper was supposed to be at a secure retreat for the week, or perhaps he was supposed to be visiting a dangerous area of town. In principle anything can be relevant, and what we do bring to bear in making such decisions probably cannot be captured in a rule.

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[195] Tooby, John and Cosmides, Leda, "The psychological foundations of culture," *The Adapted Mind: Evolutionary psychology and the generation of culture,* Jerry Fodor, *The Mind Doesn't Work That Way: The Scope and Limits of Computational Psychology,* (Cambridge: MIT, 2000)

One alternative to computationalism is connectionism, whose champions think of the brain as an associative engine. Connectionism sees "environmental interactions as an iterated series of simple pattern-completing computations."[196] Thus instead of a language of thought, cognition is fueled by detection mechanisms, motor control systems, perhaps some executive control systems, and the idea of internal indicators is dropped. The philosopher Andy Clark has picked out a class of cognitive problems that he calls "representation-hungry." Assuming a tight, fluent coupling between organism and environment is not enough to model this type of cognition. However, adding cognitive artifacts into the story may be a way of avoiding the pitfalls of representationalism. One class of such problems revolves around the ability to track things with "unruly manifestations," which essentially amounts to robust, non-stimulus bound tracking. My ability to track mid-sized items worth about $10, or lapsed Catholics, does not depend on the perceptual similarities of items in those classes. Instead, we use categories that are "unified at some rather abstract level, but whose physical correlates have little in common." The second class of problems involves the not-present, the merely possible, or the counterfactual.[197] One example would be the so-called secondary representations that infants begin to wield in the second year of life. These are not yet meta-representations, say, having beliefs about beliefs, but rather the ability to get some cognitive distance from immediate circumstances to think about the hypothetical. Thus engaging in play, infants might pretend that a banana is a telephone.[198] Our meta-representative abilities emerge around 4 years of age, when children are able to pass false-belief tests.

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[196] Clark, Andy, *Being There: Putting Brain, Body, and World Together Again*, 53.
[197] , Clark, Andy, *Being There: Putting Brain, Body, and World Together Again*, 167.
[198] , Thomas Suddendorf and Andrew Whiten, "Mental Evolution and Development: Evidence for Secondary Representation in Children, Great Apes, and Other Animals," *Psychological Bulletin* 127.5 (2001), 630.

Perceiving action as goal-directed or intentional requires understanding behavior in terms of higher-level patterns, and as aimed at achieving goals that are not themselves actualized or perceptually present. Decoupled cognition is, in Clark's sense, "representation hungry" cognition. But I am skeptical that we will gain any explanatory leverage by positing internal, neuro-logical representations. Instead, I bet that looking at how we recruit cognitive artifacts will help us understand our representation-hungry or decoupled cognition. Instructions or fully specified actions, though they would count as representations, are not the stuff to make broad-banded, flexible response out of.

In this section I have argued that we ought not to think of decoupled cognition in the standard representational terms. Let me review my arguments. Language as a syntactic and symbolic cognitive artifact is more than a mere instrument for communicating antecedently propositional thoughts couched in mentalese. An innate language of thought, though it might explain our ability to potentially think an infinite number of thoughts, is not going to be able to explain our broad-banded response, and indicator theories of content will not explain our robust-tracking or our decoupled cognition. What makes languages productive is not the same mechanism that will make our actions in a sense productive, or broad-banded. Even if we were able to think the right instructional sentences in the language of thought, the rest is not just blind mechanical execution. Having the right mentalese instructions for throwing a good curve ball no more guarantees my success than having instructions and diagrams for building a guitar guarantees any worthwhile results. Natural language gives our cognition a syntactic-symbolic decoupling. Our decoupled visual concepts give us broad-banded spatial thinking. The ability to imagine what we see rearranged in a new way, or to anticipate how something we make will look and feel to someone else, depends on our ability to free ourselves from present perceptual situations. In the next section, I summarize my arguments against Evolutionary Psychology and for my decoupled artifactual cognition perspective.

Two Desiderata Reconsidered

Two challenges to any evolutionary psychology are the cognitive flexibility that humans possess, and the gap between where natural selection left off and the kind of cognition modern humans are capable of. Neither of these is well explained by the adaptationist, nativist, and modular proposals of Evolutionary Psychology. You can string together as many modules tuned to specific adaptive problems as you like, and you will not be able to produce the flexibility of human cognition, nor is it helpful to characterize the difference between humans and our closest living relatives, the chimpanzees, in terms of simply adding more cognitive modules.

The Swiss Army Knife metaphor of the mind runs into the problem of cognitive flexibility. Decoupled cognition is non-modular. The ability to use information for a wide variety of tasks, and for any task to draw on a wide variety of informational resources, is not supported by a massively modular architecture. Evolutionary Psychologists suppose that we need cognitive modules that are tuned to specific adaptive problems that hominids faced during the Pleistocene. However, we are able to successfully perform many cognitive tasks that natural selection could not possibly have supplied us with a module for, such as making curries or building bridges. These tasks cannot be the joint product of whatever modules natural selection is supposed to have given us. By definition, the modules are supposed to be domain-specific, or tuned to the structure of very specific adaptive problems; they are supposed to be virtually useless outside of the domain that they were selected for. Much of our cognition could not be accomplished by any modular processes. I have suggested that linguistic performance, belief selection, and theory of mind as three examples. One attraction of a modular mind is that it offers a possible solution to the so-called frame problem. For massive modularity to avoid the frame problem, each module needs to be encapsulated with respect to a lot of non-relevant information to avoid computational explosion. However, belief fixation and linguistic performance are not systematically blind to any information the agent might have. Anything can be relevant in determining what you should believe, or what you should say next in a conversation. Since massive modularity is not true, computationalism looks unpromising.

Evolutionary Psychology is also not able to explain how we get from a Stone Age Mind to modern cognition. Here is an example of the problem I have in mind. One Evolutionary Psychologist writes, "Beauty experiences are unconsciously realized avenues to high fitness in evolutionary history."[199] The gap between whatever perceptual cues would have co-varied with fitness in the Pleistocene and our aesthetic responsiveness to classical music or Van Gogh paintings is enormous. No one has offered a plausible explanation of how that gap can be bridged. What is the difference between Pleistocene and modern human cognitive environments? I have suggested that the answer is artifacts and the increasingly dense and complex interactions we enter into with them. First, we are able to recruit more diverse artifacts into our cognitive performances. Calculators, recipe books, and automobiles are relatively recent inventions, and somehow we are able to make and cognitively exploit them even though natural selection did not foresee these possibilities. Instead, the cognition behind our making and using these artifacts is a spandrel, a byproduct of adaptation. Language is an artifact that has ubiquitous cognitive effects. It is supported by a lot of non-symbolic perceptual and cognitive processes, and at the same time it transforms the overall topology of our cognition.

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[199] Randy Thornhill, "Darwinian Aesthetics Informs Traditional Aesthetics," *Evolutionary Aesthetics*, eds. K Grammer and E. Voland, (Berlin, Germany: Springer-Verlag, 2003) 9.

So how do we avoid the gap problem that the Stone Age Mind creates? First, by taking development seriously. Part of our evolutionary heritage is our prolonged infant dependency produced by our continued postnatal brain growth. The relative immaturity of human brains at birth combined with neural selectional mechanisms that incorporate massive amounts of non-genetic information, ensures that our cognition is not the reflection of some distant Pleistocene environment. But this is no Blank Slate empiricist account. The flexibility problem the Swiss Army Knife model of the mind encounters can be avoided by taking the idea of decoupled cognition seriously. As I argued in the section on representation and cognition, explaining decoupled cognition will likely require that we abandon computationalism as well as the massive modularity hypothesis.

If we are not going to discover a Stone Age mind in our modern skulls, or blades of a Pleistocene Swiss Army Knife, what is the point of looking at human evolution? Evolutionary Psychologists will no doubt be disappointed, but taking an evolutionary perspective on human cognition has many fruits to bear. Hominid evolution has gone from niche-construction, via shared attention, to full blown culture. Our evolutionary endowment was not just broad-banded cognitive capacities, but open-ended ones. This is not to say that we can cognitively keep up with our artifacts; now they generate problems faster than we can cope with them. But, the reasons we cognitively fail are not because we have a Stone Age Mind, nor because our Swiss Army Knife lacks the right blade.

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