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How Jerry Fodor slid down the slippery slope to Anti-Darwinism, and how we can avoid the same fate

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Abstract There is only one physically possible process that builds and operates purposive systems in nature: natural selection. What it does is build and operate systems that look to us purposive, goal directed, teleological. There really are not any purposes in nature and no purposive processes ether. It is just one vast network of linked causal chains. Darwinian natural selection is the only process that could produce the appearance of purpose. That is why natural selection must have built and must continually shape the intentional causes of purposive behavior. Fodor's argument against Darwinian theory involves a biologist's modus tollens which is a cognitive scientist's modus ponens. Assuming his argument is valid, the right conclusion is not that Darwin's theory is mistaken but that Fodor's and any other non-Darwinian approaches to the mind are wrong. It shows how getting things wrong in the philosophy of biology leads to mistaken conclusions with the potential to damage the acceptance of a theory with harmful consequences for human well-being. Fodor has shown that the real consequence of rejecting a Darwinian approach to the mind is to reject a Darwinian theory of phylogenetic evolution. This forces us to take seriously a notion that otherwise would not have much of a chance: that when it comes to the nature of mental states, indeterminacy rules. This is an insight that should have the most beneficial impact on freeing cognitive neuroscience from demands on the adequacy of its theories that it could never meet.

Keywords Darwinian theory · Cognitive neuroscience · Fodor · Teleosemantics · Intentionality · Naturalism · Natural selection

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When a philosopher advances a purely a priori argument to show that a well-established scientific theory is fatally defective, it is usually safe to assume that the problem is the philosopher's and not the theory's.

But sometimes the philosopher is on to something, and the outcome results in an improvement in the theory or an important realization about its hitherto unrecognized implications. On these occasions, however, the philosopher is usually in the dark about what his argument has really shown.

An example is worth recalling. Famously in 1935 Einstein (along with Podolsky and Rosen) raised an a priori objection to quantum mechanics: its truth required "spooky action at a distance." Accordingly, Einstein always insisted that quantum mechanics was incomplete; there had to be deterministic hidden variables at work. Few physicists accepted the EPR thought experiment as right until it turned out that spooky action at a distance obtained, just as Einstein said it had to for quantum indeterminism to be right. In effect EPR's *modus tollens* argument was turned into a *modus ponens* that that taught us something new about reality.

This is the way we should treat Jerry Fodor's argument against Darwinian theory. [1] His *modus tollens* is a biologist's and cognitive scientist's *modus ponens*. Assuming his argument is valid the right conclusion is not that Darwin's theory is mistaken but that Fodor's and any other non-Darwinian approach to the mind is wrong. That puts Fodor in good company, of course: Einstein's.

The way Fodor went wrong is also instructive. It shows how getting things wrong in the philosophy of biology leads, and not even for the first time, to mistaken conclusions with the potential to damage the acceptance of a theory, damage with harmful consequences for human well being.

This paper first identifies the source of Fodor's rejection, two decades ago, of an important rival view about the nature of cognition—teleosemantics—in some fundamental mistakes Fodor made about the nature of the Darwinian theory of natural selection. Correcting Fodor's misunderstanding would be merely an exercise in damage control, given the glee with which his arguments were embraced by religious zealots, if it were not for the fact that at least some of his misunderstandings about Darwinian theory may be shared more broadly. The second and third sections of this paper identify these misunderstandings. The fourth section draws an important moral about the nature of cognition that Darwinian theory encourages us to take seriously.

1 The prehistory of Fodor's challenge to Darwinian theory

Fodor was fated to attack Darwinian theory long before he actually got around to it. But it took him some years to realize his fated if not fatal repulsion. It all started with teleosemantics, and his attack on the very idea of it in *The Theory of Content*.[2] But it took at least 17 years for the penny to drop and for Fodor to realize[3] it was Darwin he

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[1] *What Darwin Got Wrong*, J. Fodor and Massimo Piattelli-Palmarini, Farrar, Straus and Giroux, 2009

[2] MIT Press, 1990, particularly "Theory of Content, I." These arguments were prefigured in Rosenberg (1986a, b), I had deployed the same argument Jerry used in *Theory of Content* to advance a conclusion similar to the one I will advance here.

[3] "Against Darwinism", http://www.google.com/search?q=jerry+fodor+against+darwinism&ie=utf-8=oe=utf-8&aq=;t&rls=;org.mozilla:en-US:official&client=;firefox-a, January 18, 2007

needed to refute, not Dennett, Bennett, Millikan, Dretske, Neander, Lloyd, Papineau, Matthen and their fellow travelers.

In the period after Dan Dennett wrote *Content and Consciousness* teleosemantics became a flourishing industry. Contributions by David Papineau, Karen Neander, Fred Dretske and most of all Ruth Millikan did much to develop a naturalistic account of intentionality that exploited Darwinian natural selection.

There was of course no more serious challenge facing naturalism than the problem of intentionality. By naturalism I mean roughly the doctrine that we should treat the sciences as our best guides in solving philosophical problems. This is especially good advice in certain quarters of metaphysics, since our most reliable guide to what there is has to be physical science.

The basic problem that intentionality raises for naturalism has been obvious enough since Descartes or even Plato [*Meno*, 99]: how can a clump of matter, for example, the brain or some proper part of it, have propositional content, be *about* some other thing in the universe. What naturalism requires is a purely physical, causal account of intentionality that itself makes no overt or covert appeal to semantical concepts.[4]

Naturalism' s best resource, perhaps its only resource, for solving the basic problem of intentionality certainly seems to be Darwin's theory of natural selection. There is one huge reason for supposing so. Behavior guided by intentional states is purposive, goal directed, it is quintessentially means aimed at ends. Purposive behavior inherits its purposiveness from brain states.

As we'll have occasion briefly to explain below, there is only one physically possible process that builds and operates purposive systems in nature: natural selection. More precisely, what it does is build and operate systems that look to us purposive, goal directed, teleological. There really aren't any purposes in nature and no purposive processes ether. It's just one vast network of linked causal chains. The notion that Darwinian natural selection naturalized purposes is just a way of sugar coating its bitter pill. This is something clearly recognized by creationists and other otherwise benighted opponents of Darwinian theory. Below I'll explain why Darwinian natural selection is the only process that could produce the appearance of purpose. That is why natural selection must have built and must continually shape the intentional causes of purposive behavior. Accordingly, we should look to Darwinian processes to provide a causal account of intentional content. That's what makes teleosemantics inevitable.

Teleosemantics maintains that the neural circuitry in the frog that produces fly snapping has been tuned up by phylogenetically by natural selection and ontogenetically, developmentally, by the law of effect—operant conditioning Darwinism's chip off the old block.[5] And, it claims that the neural circuitry's intentional content consists in those phylogenetic and ontogenetic facts about it.

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[4] Of course, this is only the basic problem: the next problem is how the clump of matter can be about properties, or even harder, be about propositions—false as well as true, abstract objects such as universals and numbers, and fictional, imaginary, or impossible objects. But solving the basic problem is a sufficiently imposing challenge.

[5] Dennett (1987). For these purposes the frog turns out to be a bad example, since it's close to impervious to operant conditioning, But science shouldn't stand in the way of philosophy

This is where Fodor throws a spanner in the works. He shows it can't be done: You cannot analyze intentional content by appeal to the etiology—phylogenetic or ontogenetic—of the wet stuff in the brain, the neural circuitry that gives rise to the purposive behavior, no matter how exquisitely appropriate the behavior is to its circumstances. It's Fodorian prose at its best:

> The Moral to repeat is that…Darwin doesn't care how you describe the intentional object of frog snaps. All that matters for selection is how many flies the frog manages to ingest in consequence of its snapping, and this number comes out exactly the same whether one describes the function of the snap guidance mechanisms with respect to a world that is populated by flies that are, de facto, ambient black dots, or with respect to a world that is populated by ambient black dots that are, de facto, flies. "Erst kommt das Fressen, dann kommt die Moral." Darwin *cares how many flies you eat, but not what description you eat them under*. [*A Theory of Content*, p. XX]

The "technical" issue facing teleosemantics is indeterminacy of propositional content. The most exquisite environmental appropriateness of the behavior produced by some neural circuit's firing won't narrow down its content to one unique proposition. This is something that Quine noted. Fodor labeled this indeterminacy issue the "disjunction problem" and ever since many writers have used it as a stick with which to beat all causal theories of content.

In the actual environment in which frogs evolved, and in the actual environment in which this frog learned how to make a living, the neural circuitry that was selected for causing the frog's tongue to snap at the fly at x, y, z, t is supposed to have the content "Fly at x,y,z,t." But phylogenetic and ontogenetic Darwinian processes of selection can't discriminate among indefinitely many other alternative neural contents with the same effects in tongue snapping behavior. It's now famous that there is no way any teleosemantic theory can tell whether the content of the relevant frog's neural circuit is "Fly or black moving dot at x,y,z,t," or "fly or bee bee at x,y,z,t." or any of a zillion other disjunctive objects of thought, so long as none of these disjuncts has ever actually been presented to the fly [6] Whence the name, "disjunction problem."

2 Fodor's mistake about Darwinian processes

Once he began to pursue this line of argument against teleosemantics, it was inevitable that Fodor would eventually have to repudiate Darwin's theory altogether. The specific reason is roughly that any naturalistic, purely causal, non-semantical account of content will have to rely on Darwinian natural selection to build and operate contentful neural states. The more general reason Fodor would have to repudiate Darwin is that no causal theory whatever, including Fodor's favorite one, can account for determinate semantic content and so *eo ipso* a Darwinian theory could not do so.

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[6] It's not as though this problem of indeterminacy escaped the notice of teleosemanticists. Dennett already noticed it in Content and Consciousness, though his preferred animal companion was a dog. He detected the indeterminacy problem but he didn't solve it.

How surprising should this be? Roughly speaking, if there are any truths that are intensional in their semantics, then as we already know too well, no physical theory can accommodate them. And of course the *ante* has gone up ever since philosophers began taking hyperintensionality seriously. Imagine demanding that a physical theory ground thoughts about impossible worlds.

Since it is easy to show that Darwinian theory is a purely physical theory, it is no surprise that anyone who demands of science that it accommodate intensional contexts will have to repudiate Darwin's theory. Leave it to Fodor to make a *cause célèbre* out of an unpalatable necessity.

It's pretty easy to show that Fodor's argument against Darwin is just his argument against teleosemantics warmed over. And it's not too hard to show that phylogenetic Darwinism doesn't have to take this threat very seriously. The benefit of seeing this is not just that it takes the Mickey out of Fodor's critique of Millikan, Neander, Dretske & Co. Rather, it should begin to suggest that that no theory of content needs to solve the disjunction problem!

What exactly is Fodor's beef with Darwinism in its home base of phylogenetic evolution? It's the disjunction problem all over again: We are supposed to imagine two distinct traits, T and T', only one of which is adaptive but which are "locally coextensive," in the way that 'detecting a fly' and 'detecting a fly or a bee bee,' or any of an indefinitely large number of other contentful states are locally coextensive in frog tongue snapping etiologies.

Take some carefully chosen adaptive trait and one of its neutral or even maladaptive side effects: Consider the well-used example from the debates about selected effects analysis of biological functions: the traits of circulating the blood and making thump-thump noises. Since they go together owing presumably to physical law acting on local conditions, there is no way natural selection can pull them apart. Yet it says that one was selected for and the other was not. That is, we want to accept the counterfactual that

> Were hearts to pump without making noises, they would have been selected for anyway.
>
> We want to reject the counterfactual that
>
> Were hearts to make noise without pumping the blood they would be selected for anyway.

But Darwinian processes supposedly can't discriminate those two counterfactuals, showing the first to be true and the second to be false. Why not? Because so long as the properties are, as stipulated, locally co-extensive, one property's frequency can't change without the other's changing. So, Darwin's theory cannot say that one is selected for and not the other. This is the point Fodor made against teleosemantics: it can't tell whether fly flicking is selected for instead of fly or bee bee flicking, so it can't discriminate intentional content.

Where did Fodor go wrong?

The first and biggest mistake Fodor made, along with a lot of other people, is to suppose that according to Darwinian theory, there is any such thing as selection *for* in nature. No. There is only selection-against.

The whole point of Darwin's theory is that in the creation of adaptations, nature is not active, it's passive. What is really going on is environmental filtration—a purely passive and not very discriminating process that prevents most traits below some minimal local threshold from persisting. As Fodor might put it, Darwin doesn't care which traits get past the filter, including all the bizarre disjunctive traits any student of Nelson Goodman can come up with. Darwin only cares about which traits can't. He and his theory have no time or need for selection-for. It's a theory that gives pride of place to selection-against. And that's not a defect, weakness, oversight or problem of the theory. That's its great strength. Why?

The core of Darwin's theoretical achievement was to identify a purely causal mechanism that produces adaptations. Of course establishing that every organism and every species is a part of the single tree of life was extremely important and had a profound significance on our culture. But Darwin's real theoretical achievement was to refute Kant's dictum that "There will never be a Newton for the blade of grass."[7] Darwin's signal achievement was theoretical: identifying the mechanism—random, i.e. blind, unforesighted variation and passive, environmental filtration that sculpts the *appearance* of purpose in nature, even though there is no reality of purpose operating in it. He uncovered the processes that give rise to the means/ends economy among biological parts and wholes. This means/ends economy produced by selection-against is so widespread in nature that we have over generalized and come to detect it everywhere, even in places where it doesn't exist.

Once it is recognized that Darwin ruled out selection for, and insisted only on the causal efficacy of selection-against a lot of biological problems were resolved—including the existence of all those imperfections everywhere in nature. And it solves some philosophical problems as well, like why Darwinian processes needn't worry about differences between "real" traits and Goodmaneque traits or "Cambridge traits" or disjunctive ones like Fodor's.

To see how the process that Darwin discovered—selection-against—works, consider an example: two distinct gene products, one of which is neutral or even harmful to an organism and the other of which is beneficial, which are coded for by genes right next to each other on the chromosomes. This is the phenomenon of genetic linkage. The traits that the genes coded for will be coextensive in a population—a set of organisms—because the gene-types are coextensive. Mendelian assortment and segregation don't break up these packages of genes with any efficiency. Only cross-over (and other non selective-against) processes can do this. As Darwin realized, no process in nature (including ones he knew nothing about, like cross-over, which breaks up these packages) picks up on usefulness, convenience, need, the adaptational value of anything at all. Once environmental vicissitudes break up the DNA on which the two adjacent genes sit, selection-against can get started—if one of the two proteins is harmful.

The only thing mother nature (a.k.a. natural selection-against) can do about the free-riding maladaptive or neutral trait, whose genes are riding along close to the genes for an adaptive one, is wait around for the genetic material to be broken at just the right place between their respective genes. Once this happens, in Fodor's words, Darwin can begin to tell the difference between them. Of course as molecular biology

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[7] *Critique of Judgment*, section 75.

develops we'll be able to act as a source of variation, to effect these breaks with restriction enzymes, and then as a filter that can accurately knock out any neural or maladaptive or for that matter any otherwise adaptive gene we like.

Fodor's objection to this story is that Darwinian theory can't tell the difference between these two genes or their traits until cross-over breaks the linkage between the gene that is going to increase its frequency and one that is going to decrease its frequency.

As we have already noted, Darwin doesn't have to tell the difference between them if one is an adaptation and the other is neutral. It's only selecting-against. What is more, Darwinism tells us to look for adaptations all over the place, and not be anthropomorphic about it. In this case the beneficial protein and its associated gene are not selected against just because the trait is beneficial to the organism; meanwhile the harmful protein is not selected against because its gene has a trait beneficial to itself (and to its protein-product)—its location on the chromosome hard by the gene for the beneficial protein. That's why neither harmful gene-product nor the gene that produces it is selected against.

I suspect that Fodor and a lot of other people have not noticed that 'selection-against' isn't the contradictory of 'selection for.' The failure to realize that these two terms are contraries, and not contradictories is one of the strongest encouragements of overzealous adaptationism in biology and outside of it.

Why are they not contradictories? That is, why isn't selection-against trait *T* just selection for trait *not-T*? Simply because there are traits that are neither selected-against nor selected-for. These are the neutral ones that biologists, especially molecular evolutionary biologists, insist upon so strongly. 'Selection for' and 'selection-against' are contraries, not contradictories.

If they wanted contradictories evolutionary biologists could do what economists have done. Economists define 'a is weakly preferred to b by x' to mean 'a is preferred to b by x or x is indifferent between them.' They did this because they needed to allow for indifference between alternatives in order to prove important theorems in mathematical economics. For different reasons—e.g. to avoid accusations of jejune adaptationalism, biologists may want to do the same thing. Biologists could define 'a is selected for' to mean 'a is not neutral or not selected against' On the model of 'weak preference', we might call this 'weak selection for.' In fact, they probably will do so if Fodor's misunderstanding of Darwin's theory gets any traction.

If we adopt this terminological clarification, there will not be much left to Fodor's arguments against Darwinism. But what if biologists benightedly insist that it's not enough to explain evolution purely as selection-against traits just bad enough not to make it through the environmental filter. Suppose they demand that Darwin's theory distinguish traits selected for from traits weakly selected for. Well, there are still other fundamental errors in Fodor's take on Darwin's theory that vitiate his criticism of it.

Let's consider the sorts of traits that Fodor thinks differ in regard to adaptation and just can't be separated by selection. Consider for example, the property of binding oxygen and the property of reflecting red light. These two properties are coextensive in all metazoan's respiratory systems, because the heme molecule that transports oxygen contains iron molecules that make them red. The problem, Fodor says is that natural selection has to be able to select for oxygen transport without selecting for reflecting red light. For it to be able to do so, natural selection has to make it true that

If a molecule binds oxygen, then there would be selection for its presence in metazoans

And false that

If a molecule reflects red light, then there would be selection for its presence in metazoans,[8] [9]

Fodor argues, for the former counterfactual to be true requires that there be a law to the effect that

If a molecule binds oxygen, then there is selection for its presence in metazoans

But there is no such law. In fact, there are no laws about the selection of any trait. Now the argument that Fodor gives for this claim is pretty superficial. It's that selection is context dependent, and laws can't accommodate all the different contexts, so there are no statable counterfactual-supporting universal generalizations of the sort required for the theory of natural selection to be true.

3 Fodor nomological double standard

It's remarkable to read the exponent of the existence of laws in the special sciences making the demand that Darwin produce laws of selection supporting such unqualified counterfactuals. Nothing would be easier than making the *tu quo que* point that the same challenge can't be met by the alleged *ceteris paribus* laws of the special sciences. In fact, the temptation is too great to resist, at least for a paragraph or so (and it will have a pay-off down the road too):

Recall the famous argument of "Special sciences (or the disunity of science as a working hypothesis)" [10] that, owing to multiple realizability, the proprietary regularities of the special sciences are not derivable from those of physics, since their kind terms are not definable in terms of the kinds of physics. Nevertheless, these disciplines identify laws and use them in explanations. Fodor's example was Gresham's law: that bad money will always drive good money out of circulation. Another such example is the Philips Curve regularity that increases in the rate of inflation increases employment.

Of course, *pace* Fodor's unargued assertion,[11] these "laws" don't support the counterfactuals Fodor needs them to. Take Gresham's law for example.[12] There are many cases where this doesn't happen and some in which the reverse happens. The

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[8] Notice that if we interpret 'selection-for' in this counterfactual as 'weak selection for', which is the right interpretation, it turns out true, not false. So there is no difference between these counterfactuals that requires explanation in terms of laws. That's why little remains of Jerry's argument once we recognize that the theory makes claims only about selection-against.

[9] In any case, we'll see below that these are not the counterfactuals Darwin needs to get straight.

[10] *Synthese*, 1979, v 28, pp. 97–115

[11] See for example, "Against Darwinism," p. 10, where Fodor invokes "the effects of unsystematic, interacting variables" to obscure the power of *ceteris paribus* laws to support counterfactuals. The trouble is no special scientist is in the business of enumerating these variables, nor can they owing to their large number, their heterogeneity, and the vagueness of their descriptions. The Gresham's law example in the text shows the problems with this claim.

[12] I deal with the Philips Curve in example in Rosenberg (2012).

way to save Gresham's law from these cases is to revise it and qualify it: for example: bad money drives good money to a premium, or may be governmentally overvalued currency drives governmentally undervalued currency to a premium. One problem with the former qualification is its vagueness, and one trouble with the latter qualification is its falsity. The only way to avoid these problems is to qualify these "laws" repeatedly until they become analytic truths. Alternatively, one can deny that "Gresham's law" is a law at all, and allow that it is a short hand way of adverting to a set of insights about particular cases in monetary history, which, without being laws, do support some difficult-exactly-to-specify counterfactuals that were true in those historical cases. The same goes for the Phillips curve local invariant regularity of macroeconomics, and all of the other inexact, *ceteris paribus* so-called laws of the special sciences.

Note also that this is why these "laws" are not reducible to laws in non-special sciences. Their kind terms are non-projectable predicates that the special sciences employ in their local causal claims.

If Fodor's favorite "laws" in the special sciences can do explanatory work without supporting broad, unqualified, robust counterfactuals, then of course so can non-counterfactual-supporting statements about selection-against, weak selection-against, and for that matter, the selection for that he and lots of other people believe Darwinism requires.

Where are the real laws are that underwrite these local causal claims and their associated counterfactuals? This is an important question to which the philosophy of biology provides an answer we can generalize to all the special sciences.

There are no laws about what is common and particular to selection-against, or selection for. That's because there are no laws in biology. But there are lots of well-supported counterfactuals in biology, especially in evolutionary biology, that Darwin's theory supports. How is that?

To begin with, it's clear that selection-against has produced a lot of adaptation. When environmental filters remain in place for geologically long epochs the filters get turned into fine-tooth combs, so fine that the result of selection-against becomes unbelievably refined adaptations. It's the failure to see that Darwinian processes are selection-against that leads people to overshoot and become adaptationalists. We have Gould and Lewontin[13] to thank for bringing to their senses those sociobiologists, evolutionary psychologists and other Darwinians guilty of *trop de zele*. Not everything that has evolved by selection-against is an adaptation of course. Besides all the neutral traits and the Goodmanesque, Cambridge and Fodorian disjunctive traits that manage to pass through the filter, a lot of traits are the result of a good deal of purely physical constraint, along with the constraint of prior adaptations now fixed by their developmental genetic priority. Plus there are some preadaptations that emerged by selection-against screening for other duties; and there are variable amounts of shear genetic drift. But if there are any adaptations at all not even Gould and Lewontin at their killjoy best suggested that there is any alternative to the process Darwin discovered for sculpting them by selection-against. How many of the traits of biological organisms are adaptations and how many are not, is a debatable question to which answers vary over time in different subdivisions of biology. As I read the

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[13] Gould and Lewontin (1979).

recent history especially of molecular biology, it seems to me that more and more of the genome which used to be considered "junk" or neutral sequences, just carried along for the ride, is now turning out to be adaptative.

So there is a debate about how many of the biologically interesting traits of creatures are adaptations or not, and debates about whether any particular trait is an adaptation or not, and further debates about what it is now an adaptation for, or what it previously was an adaptation for, or what its parts where previously adaptations for. But what is not up for grabs in biology is how adaptations, if there are any, ever arose in the first place. Among those traits that are adaptive, that fit into some organism's or plural organisms' ends/means economy, the only way they could have arisen, consistent with the laws of physics, is the passive, selection-against way that Darwin discovered.

There are many ways to test and confirm hypotheses about whether a trait is an adaptation, or the degree to which it is an adaptation, of which comparative phylogenies, and the use of optimality models are only two. Once this is established there are ways to test and confirm the hypothesis that the particular trait was the product of a process of blind variation and natural selection. But none of these claims about the selection of particular will rise to grandeur of laws. Why not?

It's Darwin's theory, or rather the process that he discovered for sculpting adaptations that excludes the possibility of laws of selection, or of any other sort of biological laws, that's why.[14] This is the recognition, due in its full originality to John Beatty,[15] that all biological regularities that obtain on the Earth are contingent on the evolutionary processes of blind variation and environmental filtration. Any contingent generalization true of all or most or many of the members of any biologically kind obtain only in virtue of the operation of blind variation and environmental filtration on local conditions. Their dependence on local conditions makes them all non-nomological. Moreover, for the same reasons they will cease to obtain at some point owing to the operation of the same process on local conditions. Nothing in biology is forever.

Here is a quick but fairly complete tour through the biological regularities that makes it clear why none are laws, and all are only local and temporarily invariant regularities:

Beginning at the lowest level of generality there are claims about particular species:

Humans have 23 pairs of chromosomes.
Robins' eggs are blue.

As generalizations these propositions are falsified of course, by random variation that is continually producing counter-examples. The regularities came to be roughly true as a result of natural selection-against operating on local conditions. They may not remain even roughly true: predators glomming on to and selecting against blue

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[14] The lack of laws in biology is in fact heavily over-determined. One reason is that all species are spatiotemporally distributed individuals, so that all biological kinds are implicitly spatiotemporal restricted predicates, owing to their conceptual connections with particular species, families, genera, that have occurred on this planet. But there are other less tendentious arguments for this conclusion. In *The Advancement of Science* (1993) Kitcher offers one such argument. The argument given above is the one most relevant to the present discussion.

[15] Beatty (1995). Beatty first articulated this thesis as far back as Beatty (1983).

eggs (and bleen ones for that matter) will put an end to this regularity or to Robins altogether.

Moving up to higher taxonomic levels we find regularities like
Snakes have scales.
Mammals have four-chambered hearts.

Such regularities are also false, and made so by the same processes that make regularities about particular species false.

Then there are apparent regularities that cut across higher taxa:

Arctic species have lower surface area to volume ratios than non-Arctic species in the same family (because lower ratios of surface to volume reduce heat loss).

Not only are all of these generalizations vitiated by exceptions, but even if they happened to be true for some period, we can be confident that local conditions somewhere and some when will make them false. And we can easily conjure up or create circumstances compatible with the laws of physics and chemistry that will make them false. (Global warming may be doing it for us.) On the other hand, we can employ the foregoing generalizations in explanations. They are not laws and don't pretend to be. Rather they summarize local causal relations that obtain in virtue of much more fundamental laws operating on local conditions. These regularities are local historically contingent patterns.[16] The only counterfactuals they support are equally local and hedged around with *ceteris paribus* clauses.

Here are two more well known local regularities made approximately true for a limited time by the forces of natural selection:

> *Mendel's law of segregation* In a parent, the two alleles for each character separate in the production of gametes, so that only one is transmitted to each individual in the next generation.
> *Mendel's law of independent assortment:* The genes for each character are transmitted independently to the next generation, so that the appearance of one character in an offspring will not affect the appearance of another character.

Consider the most fundamental claims about all biological systems, such as:

All genes are composed of DNA.

Or the central dogma of biology, enunciated by Francis Crick (1958):

Genetic information moves from DNA to RNA to proteins but never backwards from protein to RNA to DNA.

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[16] At this point, Jerry may interject, with exasperation, that's my point: "Adaptational explanations are a species of historical narratives. If so, then everything can be saved from the wreckage [of evolutionary biology] except the notion of selection for, since historical narratives don't support counterfactuals, it's likely that selecting for can't be salvaged." "Against Darwinism", p. 20 Aside from the fact that Darwinism doesn't need selection for, and Fodor's arguments don't apply to selection-against, he doesn't seem to recognize that he has stumbled over the fact that all explanations in what he called the "special sciences"—including cognitive science—turn out to be historical explanations, if adaptational ones are. Why this is so will be obvious by the end of this paper.

If either of these ever was true, it is true no longer owing to the arms race that produced the retrovirus. During the period it was unexceptionally true, that was the result of a local competition among molecules that carried hereditary information. One of them just happened to be much better at it in the local conditions that obtained on the Earth than the others. But things didn't have to turn out that way. There were many contingencies that resulted in the nucleic acids winning the race. And as for the central dogma, well, it has been falsified at least two different ways since Crick enunciated it.

There are also lots of models, especially mathematical models in biology, and biologists call some of them laws, such as the Hardy–Weinberg Law and the Fisher sex ratio model.[17] These models are of course mathematical truths. They support no (synthetic, contingent, causal) counterfactuals. Like Euclid's axioms, they are approximated to greater or lesser extents in some domains and not to others. Indeed owing to the operation of blind variation and environmental filtration the same mathematical model may apply to some populations at one time and fail to apply to them at other times.

Because the process of blind variation and natural selection, the persistence of blind variation and the effectiveness of the environment in filtering among variants, can make or break, indeed does make and break all of these regularities, none of them are laws. But they have important explanatory roles in biology. They have these roles only because of the operation of *real* laws on the local conditions in which they emerged and which enable them to persist.

But what laws are these real ones that underwrite the causal diagnoses made by these local regularities? Fodor thinks that the relevant real laws underwriting all these local regularities have to be some laws that mention natural selection and in particular selection for. These will be the laws that tell us what all cases of selection for have in common. Fodor demands that Darwinian theory produce such laws and argues that it can't. He wants to know which law in the theory identifies what all cases of adaptation have in common besides being cases of adaptation. He says that the law has to be of the form, "If x has property P, then x is selected for" and he has a nifty argument to show that there is no such law.

But that's not the law Darwin needs to underwrite all the regularities we canvassed above. All Darwin needs is the law that every case of adaptation is the result of a process of blind variation and passive environmental filtration of selection-against. It's pretty easy to show the role it plays in arranging the local facts reported in all the spatiotemporally restricted regularities of biology.[18]

This generalization is plainly contingent. We can imagine circumstances that would tend to falsify it: evidence of the intervention of a designing deity, or the repeated spontaneous appearance of arrangements that fulfill the complex means/ends

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[17] *Hardy-Weinberg law:* In a large, randomly mating population, and in the absence of mutation, immigration, emigration, and natural selection, gene frequencies and the distribution of genotypes remain constant from generation to generation. *Fisher's sex ratio model*, roughly stated: If males are less frequent than female, males have higher fitness, and females genetically disposed to bearing males will have more grand off-spring, increasing the frequency of genetic disposition to have more male off-spring and increasing the number of males until the proportion of males exceeds 50 %. The process will then operate in the reverse direction, maintaining the sex ratio around a stable 1:1 equilibrium.

[18] That's what Beatty did in the "The environmental contingency thesis."

economies that lead us to credit traits with being adaptations, or again evidence of Lamarckian processes whereby use and disuse in one generation leads to adaptational improvements in later generations. There are others.

Moreover, this generalization is well grounded in physical theory. In fact it identifies the only mechanism that physics countenances for the emergence of adaptations. Physics ruled out real goals, purposes, ends, teleology in general as causal forces in the universe long about 1660. In all the changes and improvements that physical science has experienced since Newton's time, the one fixed point has been a steady refusal to allow for anything even resembling real purposes to play any role in nature. The same goes for designing deities, or minds of any kind.[19] Because of this self-denying ordinance, physics therefore requires that any physical process that builds adaptations has to start at a point of zero adaptation, and build the merest, tiniest, first sliver of an adaptation from nothing at all, and do it all by purely physical processes.

In fact there is only one way that physics will even permit itself to try to build any adaptations at all, from the state of zero adaptation. Physics requires that any process in nature that is asymmetrical be driven by the 2d law of thermodynamics: the law that entropy, disorder, almost always increases, and that local increases in order must almost always result in great disorder elsewhere. All the other fundamental laws of physics are time symmetrical—the processes they describe don't have an intrinsic time order from earlier to later. Any process that goes only in one direction must be driven by the 2d law. That means processes that build adaptations, which are asymmetrical processes, *par excellence*, have to be driven by the 2d law.[20] It also requires that they be wasteful processes, using up more order in producing adaptations than the order that the adaptations constitute and maintain.

It's clear that the only way to build adaptations consistent with these two requirements is to start by processes that randomly build large numbers of alternative molecular structures just through the operation of thermodynamic noise, and then wait. Wait for what? For one or more molecules to turn up randomly that combines thermodynamic stability with replicability. Eventually out of shear thermodynamic noise there may come to be a molecular structure sufficient to withstand the local environment and that also encourages the emergence of copies of itself out of the atoms floating around in the thermodynamic noise. This can happen by templating, catalyzing or otherwise producing copies of itself. You probably don't have to wait more than 500 Ma, once the chemical constituents of the early Earth were around for this to start to happen. Once it does happen, iteration of the same process will produce more and more adaptation, at greater and greater expense, just as the 2d law requires.

The important thing to notice about this scenario for making adaptations is that it is the only one that physics will permit, and that it is the process of natural selection that Darwin discovered. The only way the first or any adaptation can arise is by blind variation: that is the only physically possible source of adaptation that the 2d law will allow. It won't be a likely outcome and certainly not common in any universe as large

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[19] Except for the bizarre possibility of Boltzmann Brains, a cosmological hypothesis that gives the philosophers use of science fiction *carte blanche*.

[20] Of course, the fact that the 2d law is the odd man out when it comes to symmetry has suggested to many philosophers of physics that it is no law after all, despite the fact that it supports counterfactuals with the best of them. Don't mention this to Jerry.

as our own. Once the merest sliver of an adaptation emerges by dumb luck, the only way it can persist is if it withstands the vicissitudes of environmental filtration—the assault on orderliness that the 2d law enjoins. Since nothing lasts forever, not even diamonds, the only way the initial adaptation-kind can persist is by multiplying its instances, again at great cost in increasing entropy. But once the process gets started, the rest is history—in this case, natural history.

So, it's the operation of the laws of physics on local conditions that produces the process of blind variation and environmental filtration that sculpts adaptations. That is the only thing all adaptations have in common. What distinguishes them from one another are the local conditions in which their incipient forms emerged, the local conditions in which these forms were improved, and the local conditions in which they were worsened and eventually became extinct.

To get the causal counterfactuals that Darwinism really needs to support to come out true, all you need are the laws of physics operating on boundary conditions. Of course you will need lots of these laws and lots of detail about the boundary conditions to get the details right. To illustrate let's consider the two counterfactuals about heme molecules that Darwin really needs to get right:

It should be true that

> If a molecule didn't binds oxygen well, then there would be selection-against its presence in metazoans

And false that

> If a molecule didn't reflect red light, then there would be selection-against its presence in metazoans

So why does the binding-oxygen counterfactual come out true and the reflecting red light counterfactual come out false? Well, given the physical and chemical laws that drive the process of respiration, and the local environmental conditions on Earth under which being aerobic evolved to be almost (but not quite) universal among metazoans, variations that enhance oxygen binding among them would lead to more off-spring and ones that reduce it would lead to fewer. The same almost universal claim cannot be made for molecules that reflect red light better or worse than iron-complex molecules like hemoglobin. No laws about selection-for operating, because there are no laws of selection, -for or-against. None needed either. The laws of physical chemistry operating on local conditions do all the work. Just check out any textbook of molecular biology.

What about the Fodoresque sounding problem that when blind variation and environmental filtration result in changes in the frequency of oxygen-binding molecules in metazoans, they also result in changes in the frequency of oxygen binding or hexed molecules in metazoans. (A hexed molecule is one that has 8 protons, 8 neutrons and has been blessed by a qualified witchcraft practitioner.) Well, this may be a problem for the theory of natural selection, but it's also a problem for every other law ever promulgated in science. It is the good old problem of crafting a principle of empirical meaningfulness that will enable us to tell the scientific wheat from the non-scientific chaff. We can employ "hexing" to make trouble for any theory in any science trying to justify its explanatory claims or its description of its *explanantia*.

One might be tempted to think that there is a distinct putative Darwinian law-like statement that identifies what all adaptations have to have in common: they all result from the operation of the so called Principle of Natural Selection:

PNS If a is fitter than b, then probably a will have more descendents than b.

The PNS is a pretty notorious bone of contention in the philosophy of biology. Philosophers have taken almost every conceivable side of the questions of whether it's any part of Darwin's theory, whether it's a law or not, and if so how its crucial terms—'fitter than', and 'probably' are to be understood, as well as its relations to its substitution instances, especially ones that seem to make it come out false. The long and the short of this debate is that who is right about these matters turns pretty much on what you decide about the meanings of those two terms, 'fitter than' and 'probably.' If 'fitter than' is an "accounting term", which conveniently summarizes all the actual local causal factors that determine demographic shifts from generation to generation among large populations, then the argument that the PNS is a definitional truth becomes pretty compelling. [21] The widely held probabilistic propensity definition of fitness[22] is another reason for treating the PNS as a definition: So understood, the antecedent makes a claim about the probabilistically expected number of off-spring and the consequent makes a claim about the objective chances of certain demographic outcomes. Depending on how these two types of probability are related, the PNS sails very close to the winds of analyticity.

One way to preserve the nomological status of the PNS is to treat fitness as an undefined term (for a multiply realized property) in the theory of natural selection and seek its empirical interpretation from ecological context to context. Interpreting the PNS as a law about the consequences of a relationship between organisms, or whatever replicates, and environments that is multiply realizable, and highly context sensitive. But this interpretation doesn't have many operational advantages. That is probably the reason hardly anyone but the present author has ever advocated it.[23] In the present connection it is however quite illuminating. For this way of thinking about fitness and the PNS shows that there is nothing that all cases of selection have in common. Fitness is, as Fodor would put it, context dependent because it's multiply realized. This way of thinking about fitness makes the PNS into one of Fodor's "special Science" laws, true only *ceteris paribus* for a limited domain, without any predictive power or relevance to broad counterfactuals, and certainly not a law that can be reduced to physical laws.

To summarize, It's just a mistake to suppose that a theory of natural selection should be replete with generalizations "about which *ecological* variables determine the relative fitness of phenotypes." "The idea," says Fodor, "is that it's ecological laws—laws that apply by virtue of a creature's *exogenous* relations—that support counterfactuals about which traits the creature *would* be selected for *if* it had them.

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[21] This is Sober's approach in *The Philosophy of Biology* (1993). It makes a problem for philosophers like Matthen, Lewens, Walsh and Ariew who invoke the necessary truth in explanations of contingent facts. See Matthen and Ariew (2002), and Walsh et al. (2002).

[22] This approach originates with John and Mills (1979), and has been endorsed by Brandon, Sober, and many others. But see Beatty and Finsen (nee Mills) (1989), for revisionist doubts. Elliott Sober's own doubts about the propensity definition are expressed in "The Two Faces of Fitness" (2000).

[23] "Fitness," *Journal of Philosophy*, 1983

[p. 128]" No, no, no. Fodor, you don't understand biology. In Fodor-speak, biology is a science without its own proprietary laws, just like all the other special sciences.

4 Darwinian natural selection and the indeterminacy of content

Now that we have settled Fodor's hash—the one he's made out of the theory of natural selection in its home base of phylogenetic evolution, we can go back to his original arguments against teleosemantics, and consider what we should make of them.

First thing to notice is that after 50 years or so of trying to come up with a purely causal theory of psychological content that is completely semantics free, no one has yet succeeded. And that includes Fodor's own beloved asymmetrical causal dependence theory. [24] Physicalism dictates that psychological states and processes that have intentional content, are just "upgraded neural states" that track the proximate and non-proximate environment with a discriminating enough sensitivity to qualify as representations of particular states of affairs. What counts as 'discriminating enough sensitivity' is relative to the function of the neurological structures that embodies the representation. Since (*pace* Fodor) functions are selected effects that already makes teleosemantics the only possible candidate for a theory of content that is itself intentionality free, that satisfies the physicalist demand that intentional content be upgraded nonintentional content, on pain of begging the question of how intentionality is possible.

The reason teleosemantics is the only game in town is that Darwinian natural selection is the only way to get the appearance of purpose wherever in nature it rears its pretty little head, and that includes inside the brain. As we saw above, physics excludes all sources of the appearance of purpose except blind variation and environmental filtration. If, as is obvious, the most minimal functionalism about the mind is right, then intentional states like belief and desire have to have a function—usually to produce word-to-world fit or world-to-word fit. So, even if the words are morphemes in a Fodoresque language of thought, there is still no option but to go teleosemantic. We have to treat the neural content (fly at x,y,z,t) as a matter of Darwinian shaping of the relevant neural circuits that control frog tongue flicking. These circuits have to have been the victim of phylogenentic and ontogentic processes of blind variation and natural selection-against.

If teleosemantics is the only game in town, and if it can't solve the disjunction problem, then the right course for the physicalist is to bite the bullet, to go eliminativist, at least up to the point of denying that neural states have as their content specific, particular, determinate statements which attribute non-disjunctive properties and relations to non-disjunctive subjects, Thought really is much less determinate than language lets on. (That makes language much less determinate than it lets on too). The denial that the frog, or we for that matter, think about *flies*, instead of some (never to be expressed in words) disjunction of *flies or ... or ...* is one that we should take with the utmost seriousness. The disjunction problem is not an objection to teleosemantics. It's a fact of life for biological creatures like us.

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[24] Adams and Aizawa (1994a, b)

As for Fodor, it turns out he has done us a favor. He's shown that the real consequences of rejecting a Darwinian approach to the mind, is to reject a Darwinian theory of phylogenetic evolution. This forces us to take seriously a notion that otherwise would have not have much of a chance: that when it comes to the nature of mental states, indeterminacy rules. This is an insight that should have the most beneficial impact on freeing cognitive neuroscience from demands on the adequacy of its theories that it could never meet. Maybe it is not as important an insight as the one attained by running a *modus tollens* on Einstein. But it is an important one nonetheless.

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