

Natural Selection Doesn't Work That Way: Jerry Fodor vs. Evolutionary Psychology on Gradualism and Saltationism

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Abstract: In Chapter Five of *The Mind Doesn't Work That Way*, Jerry Fodor argues that since it is likely that human minds evolved quickly as saltations rather than gradually as the product of an accumulation of small mutations, evolutionary psychologists are wrong to think that human minds are adaptations. I argue that Fodor's requirement that adaptationism entails gradualism is wrongheaded. So, while evolutionary psychologists may be wrong to endorse gradualism—and I argue that they are wrong—it does not follow that they are wrong to endorse an adaptationist explanation for how the human mind evolved.

Introduction

According to some evolutionary psychologists, most notably Steven Pinker (*How the Mind Works*) and Henry Plotkin (*Evolution in Mind*), complex traits arise through cumulative selection of small or incremental modifications to pre-existing traits. While it is possible for a complex trait (which exhibits a number of internal parts with complex functional interactions among them) to arise, 'all at once', as it were, by a single or a few mutations of large effect, the odds of such 'saltations' producing a complex trait is extremely small. Since human cognition is an extremely complex trait it is likely that its evolution involved gradual selection of small effect mutations rather than by saltations.

In Chapter Five of his *The Mind Doesn't Work That Way*, Jerry Fodor provides reasons to be wary of this story from evolutionary psychology. In particular, Fodor doubts that our cognitive apparatus are adaptations; that is, he doubts that they are products of natural selection. While no one really knows how many genetic alterations it took to get from the primitive minds of our nearest ancestors to our rich and complex minds, comparative evidence suggests the number is few. Since our brains are very similar to apes while our minds are very different, it is quite plausible that 'relatively small alterations to the neurology must have produced very

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large discontinuities ('saltations', as one says) in cognitive capacities in the transition from the ancestral apes to us' (p. 88). If so, Fodor concludes, there is no reason to believe that our cognitive architecture was an adaptation *despite* the possibility that having a rich and complex mind is conducive to fitness (p. 88).

In this paper I wish to expose critical fallacies in the exchange between the evolutionary psychologists and Jerry Fodor. The keystone is an overlooked distinction between the question 'How did a trait first appear in a single individual?' and the very different question, 'Given that the trait is present in one or more individuals, how did it become more or less universal in the population?' Answers to the first question do not entail answers to the second. For whatever reason an individual came to have its traits is not necessarily the same reason the trait might eventually spread through a population. Gradualism and saltationism offer two possible answers to the first question about the *origins* of a trait or phenotype. Adaptationism is one of several possible explanations for the *spread* of a trait in a population.

The first fallacy comes from evolutionary psychology. Evolutionary psychologists who espouse gradualism sometimes hold a mistaken assumption about how complex traits, in general, might originate in an individual. Despite the *a priori* appeal of the argument from the improbability of saltations giving rise to complex traits, there are at least two good empirical counter-arguments from developmental biology. I will lay out these counter-arguments. Another fallacy comes from Fodor: his anti-adaptationist conclusion does not follow from his saltationist evidence. As I said above, the reason why a trait originates is not necessarily the same reason why a trait will spread. Below I will argue for a stronger claim: whether or not a trait arises out of a saltation or a mutation of small, incremental effect makes *no difference* to whether natural selection can explain the evolution of a trait (complex or otherwise). That is, it does not follow from Fodor's argument from saltation that human minds are not adaptations. Whether or not a trait is an adaptation is orthogonal to the issue of gradualism *vs.* saltationism.

1. Gradualism vs. Saltationism As An Explanation For A Trait's First Occurrence In An Individual

Let us look at the 'improbability argument' for gradualism a bit more closely. The standard argument for evolutionary gradualism and against saltationism was made famous by R.A. Fisher (1930). To illustrate Fisher's argument, consider this standard classroom rendition. Open the back of a mechanical watch to reveal its innerworkings. Then, randomly jab at the watch's innards (to simulate a mutation) with a relatively large, blunt pointer. Chances are the large alterations made are going to break the watch rather than enhance it. A random jab from a very, very fine pointer will make finer alterations that are less likely to break the watch; albeit it is not particularly likely to improve the watch either. Nevertheless, the blunter the point the more the alteration at a single blow, the more likely that the alterations will be damaging (i.e. resulting in death) rather than enhancing.

Fisher's argument—let us call it 'MA' for 'Maladaptive Argument'—is influential in the gradualist literature, e.g. Dawkins (1982). However, two effective critiques from developmental biology ought to be considered. First, MA assumes that mutations affect phenotypes directly, that is, mutations suffice for the appearance of a phenotypic effect. If they did, then it is hard to see how mutations can ever be beneficial; almost any jab of the pointer will discombobulate the watch. But to assume that mutations suffice for their phenotypic effect is to neglect the role of development as the intermediary or buffer that expresses or prevents from expressing the result of a mutation as a phenotype. Here, empirical evidence from developmental biology trumps Fisher's *a priori* MA. Development involves complex interactions between many genes, some inherited (non-DNA) extra-cellular mechanisms, and environmental conditions (Lewontin, 2000). Consequently, sometimes the effects of potentially deleterious mutations are buffered in development by modifier genes or other regulatory systems. More interestingly, sometimes minor mutations produce dramatic effects depending where or when in the developmental sequence the mutation produces its effect. For example, alteration of the 'homeobox gene clusters' or 'hox genes' produce very dramatic phenotypic effects. Hox genes clusters are suspected to be found in all the world's plants and animals, and from a limited set of developmental sequences comes an incredible array of body patterns. Consider that the difference between the two small halteres of a fruitfly (little buds located underneath the fly's wing) and the large and decorative hindwings of a Monarch butterfly depends on the developmental response by gene interactions that are regulated by a *single* target gene, '*Ultrabithorax*' (Gilbert, 2000; Levine, 2002). So, contrary to the usual way MA is told, genetic alterations do not necessarily cause the dramatic phenotypic changes directly. Rather the mutations initiate a cascade of developmental changes that result in the distinct phenotype.

The second critique against MA is that MA operates with the implicit assumption that the only way complex traits arise 'all at once' in ontogeny is through saltation mutations. However, this is a narrow view of how novel phenotypes arise. As C. H. Waddington demonstrated in the 1950s, extant populations contain a remarkable degree of genetic variation that is unexpressed in the phenotype under 'normal' developmental conditions. The unexpressed variation might be hidden with the complex interactions between genes in development or in the presence of 'suppressor' genes that negate the potential affect. Waddington called the phenomenon 'canalization'. A canalized system acts as a buffer to insure the development of stable phenotypes against both potentially harmful mutations and the vagaries of the environment (Waddington, 1957).

Waddington demonstrated that a stressful environmental condition is sometimes sufficient to express pre-existing phenotypic variation. Further, as Waddington demonstrated in his experiments on ether-shocked fruit fly larvae, sometimes the variation that results from the environmental shock is wildly discontinuous from the other variants. That is, the variation exposed by an abnormal variation features a saltation. (As Waddington put it, 'the phenotypic modification . . . would probably be considered of macro-evolutionary importance' (1957, p. 51).) As a result of the ether vapor, a subpopulation of Waddington's flies produced a second thorax ('wildtype' fruitflies possess a single thorax) complete with a second set of wings.

In an environmental context whereby bithorax confers reproductive success, bithorax could eventually replace unithorax among fruitflies. In that case, the evolution of bithorax did not have to wait for a mutation to come along, the genetic configuration for a bithorax fly pre-existed unexpressed all along. The important point here is that environmental stress, and not just saltation mutations, can produce a new complex trait 'all at once' in a population. Examples of such polyphenisms abound in nature, from sex-switching in crocodiles to morphological changes to the presence or absence of wings among ants.

The upshot here is that it is possible for a novel complex trait to arise in an individual without it being built-up by a gradual accumulation of incremental mutations passed along many generations. With this argument against the evolutionary psychologists Fodor agrees (p. c.). However, Fodor thinks that a fatal objection against the evolutionary psychologists follows: evidence of a saltation mutation precludes an *adaptationist* explanation for the evolution of the trait in question. As I will argue in the next section, Fodor is mistaken; he is wrong to equate adaptationism with gradualism. If I'm right, what follows from evidence of saltation mutations in the origins of human minds is a much more mild criticism of evolutionary psychology; namely, evolutionary psychologists are wrong to defend gradualism as the explanation for the first occurrence of a complex mind in an individual human. This leaves open the question how a complex mind becomes a universal feature of humans. Nothing in what Fodor says in his book precludes the possibility that evolutionary psychologists are right to think that natural selection explains that.

2. Fodor's Indispensability Condition For Adaptationism

Fodor thinks that gradualism is an *indispensable* condition for evolution by natural selection. He says this most forcefully in the following two passages: 'I want to stress that the assumption of more or less linear covariance is not dispensable in Darwinist explanations' (p. 89). 'To repeat: Darwinism can work only if (only where) there is some organic parameter the small, incremental variation of which produces correspondingly small, incremental variations of fitness' (p. 89). In other words, gradualism is a requirement of natural selection, while saltationism is *opposed* to selection. Fodor makes the latter claim more or less explicitly: 'if changing the physiology a little makes a very large change in fitness, the difference between a selection theory and a saltation theory disappears' (p. 89).

Fodor is mistaken about natural selection; it is false that gradualism is an indispensable condition for evolution by natural selection. Whether or not a phenotype is the product of a single or of several saltations or several mutations that confer small incremental phenotypic changes makes *no* difference to whether natural selection can explain the evolution of the trait.

Natural selection explains why one trait rather than some other is present in a population. For example, if long necks are an adaptation, natural selection explains why giraffes have long necks as opposed to, say, short or medium necks. There are three conditions for a trait to evolve by natural selection: variation, heritability, and

fitness. If it is heritable, then the fittest variant, the one that, on average, confers the highest probability of survivability and/or reproductive success, is most likely to increase in frequency in a population. (Of course this story assumes certain conditions about the reproductive scheme, the population number, etc.—the details are well-worked out in any standard textbook on natural selection.) So, presumably, at one time there were variants in neck sizes among ancestral giraffes and the ones with the longest necks survived and reproduced like offspring more successfully (on average) than those with shorter necks.

There is an important consequence to this story. For a trait to be a product of natural selection it must be the case that phenotypes *pre-exist their selection*; as it were, the trait has to be there before natural selection can favor it. So, natural selection, in this instance, explains why traits, e.g. long necks, are present by explaining the increase of frequency of long necks over other variants, *not* how the trait originated in an individual in the first place. Therefore, an explanation for the *origins* of a phenotype, i.e. how it first appeared in a member of the population, does not explain a trait's *spread* in a population.

This is what Fodor seems not to have grasped. Gradualism and saltationism are two distinct explanations for the *origins* of a phenotype while natural selection is one of several possible explanations for how a trait has *spread* in a population. Consequently, contrary to Fodor, a trait can be an adaptation—natural selection can explain its evolution—regardless of a trait's origin. The only requirement for a natural selection explanation for an inherited variant's spread in a population is that it confers relative fitness to its possessors. Hence, whether the variant arose from saltations or an accumulation of incremental mutations is irrelevant to whether the trait is an adaptation or not.

Perhaps Fodor equates adaptationism with gradualism, in part, because so many adaptationists *are* gradualists (perhaps because many are persuaded by MA). However, as I've demonstrated by the examples of hox genes and of Waddington's bithorax experiments, biologists do not doubt that selection explains the spread of phenotypes that are the product of radical genetic alterations or environmental shocks. The reason is that adaptationism is independent of the saltation *vs.* gradualism issue about the origin of variation.

Finally, define 'super gradualism' as a theory that entails both the process of small-effect mutations plus natural selection favoring certain mutations.¹ Now we have an opposition between 'super gradualism' and saltationism over the explanation of a trait's origins or how the first individual came to have the trait. A 'super gradualist' will say that the phenotypic difference between a particular individual's traits and his or her (or its) closest ancestors is very small while a saltationist would say the phenotypic difference is large. However, it would be a mistake to equate 'super gradualism' with adaptationism because however the individual gets its traits,

¹ It is pretty clear from personal communication that Fodor thinks that 'super gradualism' is the only gradualism worth talking about. It isn't so clear that Darwin, among others think so. I explore this issue in a paper currently in preparation.

the important question remains: How will the trait spread to other future individuals in the population of conspecifics? To determine that we would at least need to determine whether the novel trait is fitness enhancing or not.

3. Conclusion

So, contrary to what Fodor thinks, the tendency for evolutionary psychologists to be gradualists, while mistaken, ought not affect their working assumption that natural selection explains the evolution of certain complex traits like the human mind.

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