Debunking The Revolutionary Phenotype

Blithering Genius

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1 Introduction

This is a critical analysis of the ideas in The Revolutionary Phenotype by J.F. Gariepy. All quotes are from his book.

Before I get into the details, here is the TLDR version: the book is a tangled mess of errors and nonsense.

The book is based on the concept of a "phenotypic revolution". This idea comes from a theory (not JF's) that DNA-based life evolved from RNA-based life. This is speculative but plausible, and I think it's probably true. JF views the evolution of DNA-based life from RNA-based life as a "phenotypic

revolution": an event in which part of the phenotype (DNA) became the genotype, and the former genotype (RNA) became part of the phenotype.

He then extrapolates from this view to a dire warning: that using technology to edit genes will lead to another phenotypic revolution, in which certain technologies that are currently part of the human extended phenotype will become the genotype, and human beings will become part of the phenotype of machines. JF describes the outcome of this revolution as a master-slave relationship: the machines will become our masters, and we will become their slaves.

2 JF's Style and Misleading Metaphorical Language

Before I get into why his ideas are wrong, I want to say a few words about JF's style. The prologue is full of exaggerated claims that border on the absurd. For example:

> You are indeed holding a book which portends the end of DNA-based life on Earth.

There is nothing wrong with making bold claims, but people who have carefully thought about their beliefs almost never present them in such a theatrical way. This book often reads like a parody of bad popular science writing and/or bad science fiction.

JF uses highly metaphorical and anthropomorphic language to describe chemical and biological processes. His metaphors are misleading and confusing.

Metaphors are an essential part of communication. They can be illuminating, but they can also be misleading or confusing. Metaphors have implications, and often those implications are tacit, so they pass below the level of conscious scrutiny. Bad metaphors are a major source of misconceptions.

Edward Osborne Wilson's concept of social insects is an example of a misleading metaphor. The hives of bees and ants resemble human societies in certain ways, but there are important differences. (See Bees are Not Social.) It is misleading to think about hives as societies, or societies as hives. However, it is easy to see the basis of the analogy: both hives and societies are composed of many individuals living and working together.

"Genes print memes" is an example of a confusing metaphor. The creation of culture by human beings cannot be conceptualized, even incorrectly, as "printing". The metaphor just doesn't make sense.

JF's metaphors range from misleading to confusing. It is impossible to translate the language of the book into something that actually describes reality. In many cases, the metaphors cannot be translated into meaningful descriptions at the level of biology and chemistry.

Here is an example of JF's metaphorical language, from the book's prologue:

> The biological events described in this book are nothing short of apocalyptic. Imagine a group of living creatures who casually decide to fabricate another life form, only to realize as they see their creation come alive that it will eventually outperform them and ultimately take over.

This passage seems to refer to the evolution of DNA as a medium of information storage and inheritance. Did an earlier form of life "casually decide to fabricate" a new form of life? No, a new form of life evolved from an earlier form of life, by mutation and selection.

Here's another passage from the book, describing the same event:

> It is a fact that DNA-based life was created by another life form. The ancient life form was called RNA. Sometime after the creation of DNA, the RNA organisms lost control over it and could do nothing to stop its takeover. That is what happened here on Earth and, it can, and likely will, happen again.

Did RNA organisms "lose control" over DNA? No, the use of DNA evolved. At every step in that evolutionary process, some mutation occurred in an organism, which then made the organism better at reproducing. Did DNA "take over" from RNA? Only in the sense that DNA replaced RNA as a storage medium in certain organisms, which were then much better at reproducing.

Here's another passage from the prologue that illustrates JF's use of metaphors:

> Thus, we can now answer the question of the origin of life on Earth. The answer is quite simple, but shocking: DNA-based life was created by another life form. It was somewhat of an accident. After the initial accident, DNA became so aggressive that it destroyed its creators by outcompeting them. It killed them, ate them and gruesomely recycled them into building blocks that it then reused to produce its own organisms. We are the direct descendants of the DNA-based organisms that undertook this cannibalistic genocide.

This is a very misleading and confusing way to describe the evolution of a new form of life. All forms of life arise by "accident", or in other words, by mutation. All life is "aggressive" in the sense that it competes for resources and reproduces to excess when it can. When a new type of life evolves, it often replaces the ancestral type that it evolved from. For example, Homo sapiens replaced Homo erectus.

The evolution of DNA as a storage medium was an important event in the history of life, but it was not a fundamentally new type of event. It was an instance of evolution: a mutation occurred and was selected for.

3 The Main Errors of JF's Book

Now I will go through the main errors of the book, which correspond to most of the main ideas in the book:

- **Phenotypic servitude:** JF assumes, explicitly and in his metaphors, that the phenotype necessarily serves the genotype. This is false.
- **Phenotypic revolution:** JF proposes that what he calls "phenotypic revolutions" are a new type of evolutionary process. This is false.
- **Phenotypic forgetfulness:** JF claims that the properties of the phenotype are not heritable, and thus are "forgotten". This is false. Genes are not the only medium of inheritance.
- **Replicators all the way down:** JF believes that the properties of life extend all the way down to the quantum level. There is no reason to believe this. JF does not understand emergence.
- **The printer concept:** JF's concept of a printer makes no sense. It conflates copying with control and mutating with determining.
- **Only printer genes are selfish:** JF believes that only printer genes are selfish in Dawkin's sense of the term. This is false. The phenotype as a whole is selfish.

- **Rejection of memetics:** JF believes that memes cannot evolve to be parasitic on humans. This is false.
- **The relationship between biology and culture:** JF has a very confused idea of how culture and biology are related.
- **The phenotypic separation theory of sex:** JF explains the evolution of sex as a "queen cell" producing haploid cells. This makes no sense.
- **Robots will replace us:** JF believes that the use of gene-editing would inevitably lead to humanity being ruled over by robots. This is absurd.

4 Phenotypic Servitude

JF believes that the phenotype serves the genotype. This is a misconception.

We often use phrases such as "replicating your genes" to mean reproduction, and this isn't entirely wrong. When you reproduce, you do replicate your genes. However, reproduction is not the same as replicating genes, and your form (the human body) has been shaped to reproduce, not just to replicate genes.

There are many ways that you could replicate your genes without reproducing. You could generate spores with your genes in them, and deposit them in the ground, or send them to the depths of the ocean, where they would survive for millions of years. You could generate viruses that contain your genes, and infect other organisms with those viruses. Why don't we do those things?

Such behaviors could not evolve, because they don't replicate the phenotype. Reproduction creates new organisms: new instances of the phenotype. It is the phenotype that reproduces. The phenotype has been selected by evolution to create new instances of the phenotype: new reproducing machines. The genes are a very important part of the phenotype, but the phenotype does not "serve" the genes, even in a metaphorical sense.

JF believes that the phenotype serves the genes because mutations to the genes can be passed on, while mutations to the phenotype cannot be inherited. I will explain below that this is not entirely true. However, let's assume it is true. (For complex multi-cellular life it is very close to true.) Does the inheritance of mutations imply that the phenotype must "serve" the genes? No, it just means that the medium of inheritance is the genes.

Mutation occurs in the genes, but selection occurs in the phenotype, and reproduction creates new instances of the phenotype. Evolution involves mutation, reproduction, and selection. There is no reason to think of the phenotype as serving the genotype. Both have been selected to reproduce the phenotype.

5 Phenotypic Revolution

A phenotypic revolution is when part of the phenotype becomes the genotype, and the former genotype becomes part of the new phenotype. The evolution of DNA-based life is an example. According to JF, DNA was part of the phenotype of some ancestral life form that used RNA as a storage medium. Then DNA became the medium of information storage and inheritance. Replicating DNA became the purpose of the organism, and RNA became just a means to that end.

First, the genotype is not the sole medium of inheritance. DNA is a medium of information storage. It stores information about how to make proteins. That information is inherited via reproduction. But that is not the only thing that we inherit. You grew from a cell, not from DNA. There is information in other parts of a cell.

JF views the evolution of a new storage medium as something outside the evolutionary process, because he thinks of the evolutionary process as operating on genes. It does, most of the time, but not exclusively.

For example, humans have a different number of chromosomes than chimpanzees. This is due to a mutation in chromosomal structure, not genes. It involved DNA, but it was not a change to the information stored in DNA. Instead, it was a change to the way DNA is packaged into chromosomes. Another example is the inclusion of mitochondria and chloroplasts in eukaryotic cells. It is believed that this occurred by formerly independent cells becoming part of a larger cell, creating a new reproducing unit. Again, this change was not genetic.

So, although most evolution involves mutations to genes stored in DNA, evolution can involve mutations to other aspects of cellular structure, which can then be inherited. DNA is not the sole medium of inheritance.

The actual medium of inheritance is the cell. You grew from a cell, not DNA. By itself, DNA does nothing. The information stored in DNA is only meaningful as part of a cell, which contains the proteins necessary to "read" the information and use it to generate proteins.

JF also confuses the medium with the message. He anthropomorphizes DNA and RNA, and describes the evolution of DNA-based life as DNA "taking over". This implies that DNA has a purpose, and self-interest. But DNA is just a type of molecule that can store information. So is RNA. How could a type of molecule have self-interest?

Even if you believe that genes have their own independent purposes, it would not follow that DNA has a purpose. Genes are information stored in DNA. They are not DNA itself. The same information could be stored in RNA (although it would not be as stable) or in an electronic storage medium.

JF is confusing himself, and his readers, with bad metaphors.

The evolution of a new storage medium is not a new type of evolutionary process. It is just evolution. The storage medium does not have a purpose or self-interest.

6 Phenotypic Forgetfulness

JF claims that the phenotype is "forgetful", in that mutations to the phenotype are not heritable. For example, if you lose your hand in a car accident, you do not pass on one-handedness to your children. This is almost entirely true for complex multi-cellular life forms, and it is mostly true for single-celled organisms that exist today. However, it is not necessarily true, and it was not true for the early form of life in which DNA first emerged.

The distinction between genotype and phenotype is less meaningful for single-celled organisms than it is for multi-cellular life. When a simple cell reproduces, it divides into two cells, each of which contains all the necessary molecules for the cell's internal processes. The daughter cells do not just inherit DNA from the parent cell. They inherit all of their molecules from the parent. Mutations to any molecule in the parent cell can be passed on to the daughters.

This is not very important in modern life forms, because mutations that occur in a molecule other than DNA are unlikely to have lasting effects. Because proteins are assembled from RNA templates, which are in turn assembled from DNA templates, mutations to proteins do not usually replicate. (Prions are an exception.) However, if DNA arose by some mutation in RNA-based life, it would have been passed to the next generation during cell division, and DNA is a template for itself, so it could replicate in the daughter cells, given the right proteins.

So, phenotypic forgetfulness was not an obstacle to the evolution of DNA as a genetic medium. It is not an obstacle to a new medium arising today, either. The reason a new medium hasn't evolved in the last 3.5 billion years is probably that DNA works really well as a storage medium, and there are no better alternatives that could arise by mutation.

7 Replicators All the Way Down

JF seems to believe that the biological processes of reproduction and evolution exist at layers below that of the cell: in chemistry and even at the quantum level. He presents this as if it were a profound insight rather than an intellectual cop-out.

People often make the mistake of over-extending concepts. There is that old joke that to someone with a hammer, everything looks like a nail. To a biologist, everything looks like biology.

There are different types of order: physics, biology, psychology, culture, society. Each requires its own concepts and theories. Psychology requires different concepts than biology. Biology requires different concepts than physics.

It is a mistake to push the replicator concept below the level of biology. It has no explanatory power when applied to molecules or atoms, and it can be very confusing.

Biology emerged from physics/chemistry. Some molecules can catalyze reactions that involve other molecules. Some catalysts can join simpler molecules to create more complex ones, such as joining amino acids to produce a protein. Some catalysts can split complex molecules into simpler ones, such as splitting a protein into amino acids. Proteins can be catalysts. Together with RNA, proteins can catalyze proteins. Life emerged from this chemical loop, known as "auto-catalysis". A cell is an auto-catalytic system.

JF doesn't understand emergence. That's why he feels the need to project biological concepts into physics. He doesn't understand how one type of order can emerge from another. Biology emerged from chemistry, by the feedback loop of auto-catalysis.

8 The Printer Concept

The printer concept is one of the most confusing in the book.

There is nothing wrong with thinking of the protein complexes that assemble DNA, RNA, and proteins as "printers". This could be a useful descriptive metaphor. All three types of molecules are sequences of simpler molecules that are put together in sequential order, so there is a useful analogy to language. In each process, information is copied with high fidelity from one molecule to another: from DNA to DNA, from DNA to RNA, or from RNA to proteins. So, the concept of a printer is an acceptable metaphor for the mechanisms that assemble molecules in cells.

However, JF adds some very strange properties to his printer concept — properties that printers do not have. The following two passages are from his definition of a printer:

> Specifically, the term printer includes any entity that controls the content of the replicator, but not those that merely select replicators.
>
> The term printer is limited to those entities that have access to determining the content of the replication through mutations.

He defines the printer as "controlling" the content of the replicator (e.g. a DNA strand). What is this notion of "control"? The term "control" is psychological in origin. It refers to a causal relationship between the will of a subject and an outcome. For example, I control my car because if I choose to turn left I can turn the steering wheel and make the car turn to the left. Does a printer have control over what it prints? No. A printer is just a device that copies whatever information is put into it.

JF also uses the phrase "determining the content of the replication through mutations". This makes no sense at all. By definition, mutations are random. One does not "determine" something by "mutations". JF's notion of a printer is nonsensical. As he defines it, it has no meaningful interpretation. It conflates copying with controlling, and mutating with determining.

JF seems to believe that "printer genes" will be selected to print the "right" mutations. This is crazy. What makes a mutation "good" is that it helps an organism to reproduce. No matter what, mutations will be selected by their effects on reproduction. There is no way that a "printer" could know what mutations to insert into genes, even if it had a mechanism for doing so. And, since printer genes are a small subset of all genes, if evolution had to work through modifications of the printer, it would take much longer for any adaptation to evolve by that process. And, it wouldn't fundamentally change the process anyway. It certainly wouldn't give the printer "control" over what it prints.

JF also applies the notion of a printer to the human brain, and/or to the relationship between genes and memes (he seems to confuse the two things), as if genes could "print" memes. This makes no sense. Psychology cannot be understood via the metaphor of "printing". Although it is a stretch, you could say that genes "print" brains, but you can't say that brains "print" memes.

9 Only Printer Genes are Selfish

JF seems to believe that there is a genotype | phenotype distinction within the genotype itself: that the genes for replicating DNA are the "masters" and the rest of the genes are the "slaves", and are in fact part of the phenotype of the printer genes.

As usual, JF's view is wrong.

The master-slave metaphor does not apply to the genotype | phenotype distinction, as I've already explained. "Printer genes" (e.g. the DNA replicase gene) do not reproduce independently of the other genes. They all reproduce (or don't) as part of the phenotype. Reproduction depends on the entire phenotype, not just on the DNA printer. For single-celled organism, what reproduces is the cell. The genes in the cell either all reproduce or none of them do.

Selfishness resides in the phenotype as a whole, not in the genes and not in some subset of the genes.

JF is extrapolating from Dawkins' notion of the selfish gene. It's worth taking a moment to think about the notion of selfishness in biology. (Keep in mind, of course, that it is a psychological metaphor.)

In biology, "selfish" means "selected to reproduce itself". Forms with functions emerge in biology by the feedback loop of reproduction and selection. Selfishness resides in the unit of reproduction: the reproducing machine.

Is a gene a reproducing machine? No, not really. Genes can't reproduce by themselves. So, a gene isn't really selfish.

Is an organism a reproducing machine? Yes. So an organism is selfish. It's form was selected to reproduce. It descends from a long line of organisms that reproduced.

Genes are not little agents that pull the strings on organisms, to make them serve the interests of the gene. Genes are just information, stored in DNA. That information has effects on the organism, and those effects can increase or decrease reproduction in a specific environment. Generally speaking, genes are selected to make organisms reproduce, not the other way around.

10 Rejection of Memetics

The idea of memetics is that memes (cultural forms) can propagate from mind to mind, are selected to reproduce in this way, and can even be harmful to the reproduction of the people who propagate them.

JF rejects the concept of memetics. He seems to believe that memes necessarily serve the interests of genes because they are part of the phenotype of genes, and thus are controlled by genes.

JF's rejection of memetics is wrong. Just because memes depend on human beings, it doesn't follow that they must serve the reproductive interests of human beings.

Parasites depend on hosts, and yet parasites do not serve the reproductive interests of their hosts. A parasitic meme can evolve in the same way that a parasitic tapeworm can evolve. In both cases, the reproduction of the parasite is not linked to the reproduction of the host, and so the phenotype of the parasite can evolve to reproduce itself at the expense of the host. Meanwhile, the host phenotype will evolve to defend itself against the parasite, but there is no guarantee that it will be able to prevent infection. And of course, there are many parasites and diseases that exist in nature. So JF's argument is clearly wrong.

11 The Relationship Between Biology and Culture

JF's view of the relationship between biology and culture is confused. He says:

> 1. Do DNA quenes have access to modifying the quenes of human culture? Answer: Yes. DNA can produce different brains that will modify the culture they pass on in various ways. Everything in human culture, from single letters to syllable to the entire meaning of a sentence, and even the emotional meaning of an entire story, can be modified by a human brain.

2. Do the quenes of human culture have access to modifying DNA quenes? Answer: No. At the moment of writing this book, no human culture on Earth has reached a point where it determines which letters of DNA are to be modified in a human baby.

(I'll ignore the silly term "quene" here, and use the terms "gene" and "meme" instead.)

What access do genes have to modifying memes?

Brain structure is (mostly) determined by genes, and memes are partially determined by brain structure. Genes do not modify memes. Genes are just information, and that information does not change during a person's lifetime.

For example, a child growing up in an English-speaking family will learn to speak English, by the psychological process of induction. That process is an evolved mechanism, which is determined (not controlled) by genes. In a French-speaking family, the same child would learn to speak French. The English language is not "printed" by the genes of English people. It is part of culture that evolves over time. The human brain has the evolved ability to learn a language, but languages are not encoded in DNA. A language is part of culture. It is information that brains acquire from other brains.

Control involves selecting one thing instead of another. The brain has mechanisms that select memes, so you could say that the brain controls its internal memes, although it doesn't fully determine them. A gene doesn't select anything. It is just information, which is expressed in the phenotype — in this case, the structure of the brain. The causal relationship between genes and the phenotype is *expression*, not *control*.

Evolution can select for one gene instead of another, and thus for one type of brain instead of another. Biological evolution can change culture by changing the brain, or changing the average properties of brains.

What access do memes have to modifying genes?

Culture is essential to human existence and reproduction. Human beings cannot live without the knowledge that they acquire from others. Culture affects genes by determining the conditions in which humans live, and thus what biological traits are adaptive.

For example, humans have been using fire for at least a million years. The use of fire is a meme. It is a collection of ideas and behavior patterns that we can learn from imitation and communication. This meme has affected our genes, and our bodies. We are "fire-apes", adapted to the use of fire. Our digestive systems are much smaller than those of chimps or gorillas. Our teeth and jaws are smaller. We have biologically adapted to eating cooked food. A human could not live on the diet of a chimp or a gorilla.

So, culture affects biology via evolution.

Culture and biology affect each other in the same way: via evolution. Genes and memes co-evolve. They adapt to each other.

12 The Phenotypic Separation Theory of Sex

I didn't read this section very carefully, because I was really sick of the book by that point. However, in skimming over it, it seemed to be missing something. JF proposes that sex evolved by

the production of haploid “helper” cells by a diploid “queen” cell. This doesn’t make sense because single-cell replication does not produce offspring of a parent: it replaces the parent with new “daughter” cells. So, sex could not have evolved as a way to produce helper cells, because the queen cell would be destroyed by the creation of the helpers.

Did I miss something? Or did JF?

13 Robots will Replace Us!!

> What you find on your planet is a robot populace busy exploiting some creatures that bear only the faintest physical resemblance to humans. These unfortunate, humanoid creatures live in servility to their mechanical overlords, and though you attempt to provoke them into open revolt against their slave-masters, no one listens.

In the prologue, JF promises to tell us how life as we know it will come to an end. In the last chapter, he tells a story of how gene-editing technology leads to humanity becoming part of a machine’s phenotype.

This is a new twist on a standard science fiction narrative. The “robots take over the world” narrative is popular because we find group conflict narratives emotionally compelling, and because it is easy to imagine anthropomorphic robots. Like most popular science fiction narratives, it will never happen.

In JF’s story, computers not only take over the function of printing genes, they also somehow evolve to become self-replicating “life-forms”. The master-slave relationship between humans and technology then reverses. Humans become merely part of the phenotype of computers.

In the story, memes determine genes. This is ironic, considering JF’s view of the relationship between genes and memes. The idea of having perfect children (a meme) propagates, and ends up determining the human genome.

The story doesn’t prove anything or demonstrate anything. It isn’t a thought experiment in which premises are presented and conclusions are drawn logically from those premises. It is just a story, which JF makes up as he goes along. The events of the story do not follow logically or probably from the premise that humans start using gene-editing technology to design their children.

What would happen if we started using gene-editing technology to select the genes of our children? It would depend on who controls the technology. If the technology is state-controlled, there is a risk that the state would use the technology to breed a compliant population. On the other hand, if individuals select genes for their children, there could be a tragedy of the commons in which everyone competes to have superior children, and we end up with a surplus of beautiful geniuses and no one to pick up the garbage and flip the burgers.

There is another possibility, however. We could collectively develop social rules about how the technology is used, and use it in a way that benefits individuals and society as a whole. We might eventually evolve to become as dependent on gene-editing technology as we are on fire, but that wouldn’t make us slaves to machines, any more than we are slaves to fire.

I don’t know exactly what would happen if people started using gene-printing technology to create designer children, but I can confidently predict that it would not lead to robots taking over the world. Robots will never take over the world, because robots are gay.

Thank god that's over! I've written enough about a book I never wanted to read in the first place!