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Darwin's Causal Argument Against Creationism

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1. Introduction

Charles Darwin famously referred to *On the Origin of Species* (1859) as his "one long argument" for the theory of evolution. His argument consisted of both positive evidence for his theory—for the existence of natural selection and its ability to explain the diversity of species and their curious fit to their environments—and his negative arguments against competing views. This negative component underwent significant changes across Darwin's subsequent works, from *Fertilisation of Orchids* (1862) through his final reflections published in the posthumous *Autobiography* (1887), both in its targets and arguments. Darwin's chief target in the *Origin* is the doctrine of special creation, the view that God created each species and its traits in roughly their current form, via distinct acts of creation. In later works, Darwin turns his criticism on other alternatives, including Richard Owen's archetype theory and new theories of theistic evolution, particularly as articulated by his beloved interlocutor, Asa Gray.

Accordingly, Darwin's argumentative strategy shifted as well. In the *Origin*, Darwin relies on arguments from imperfection, cases of rudimentary or otherwise imperfect traits that are hard to explain on the hypothesis of intelligent and benevolent design. However, Darwin vacillates between conflicting (bordering on contradictory) arguments, sometimes arguing that imperfections are evidence against God's design and at others suggesting it is impossible to have any evidence for or against God's design. Darwin grasped many of the limitations of his arguments in the *Origin*, lamenting that "I am, and shall ever remain, in a hopeless muddle" (letter to Asa Gray, November 26, 1860).

In later works, especially *The Variation of Animals and Plants Under Domestication* (1868), Darwin shifted to a different argument which seems to have dispelled his hopeless muddle. According to the argument from independence, the fact that variation is random with respect to selection shows that biological phenomena are not designed, via special creation or otherwise. He was much more confident in this argument, writing near the end of his life that "there seems to be no more design in the variability of organic beings and in the action

of natural selection, then in the course which the wind blows …. I have discussed this subject at the end of my book on the Variation of Domesticated Animals and Plants, and the argument there given has never, as far as I can see, been answered" (1887, 309).

Here, I will undertake a rational reconstruction of Darwin's evolving argumentative strategies against his creationist opponents. First, it will be important to explain Darwin's own understanding and interpretation of his creationist targets.[1] Second, given these background beliefs, why did Darwin initially pursue the argument from imperfection, and why, later in his career, did he find the argument from independence much more compelling? Lastly, I will reconstruct the argument from independence, asking whether — both by Darwin's own lights and our own epistemic situation today — the independence of variation and selection actually serves to undermine design. If so, how?

I will show how the shift in Darwin's thinking developed during his decades-long (1855–1881) correspondence with Gray, a philosophically rich dialog in which the two tackled previously confused concepts of chance, design, and natural law (Lennox 2010). During this debate, Darwin seemed to glimpse an as-of-yet unappreciated facet of probability: its relationship to causal inference. Philosophical study of probabilistic causality has exploded in recent decades and its tools been put to extremely fruitful use (Hitchcock 2021). I will suggest that Darwin presaged some of these insights, using patterns of probabilistic independence between variation and selection to argue that there could be no designing cause behind natural selection.

In Section 2, I will briefly introduce some modern causal modeling tools which will be used to model and explicate Darwin's arguments. In Section 3, I will discuss the argument from imperfection and its limitations. Section 4 will introduce the theory of theistic evolution. In Sections 5–7, I will reconstruct the argument from independence and Darwin's support for its premises. Objections to the argument from independence and an assessment of its plausibility will be discussed in Sections 8–10.

1. As a reviewer pointed out, Darwin's own understanding of creationism was perhaps somewhat limited. There might have been creationist views that escaped his criticisms but of which he was unaware.

2. Causal modeling

I will argue that Darwin increasingly drew on insights about how patterns of probabilistic dependence and independence indicate the presence or absence of causal relations. To make this case, it will first be necessary to lay out some basics of this approach to assessing causal relationships and to contrast it with an alternative, the process approach.

A process account of causality sees causes as those states of affairs that have the capacity or power to bring about other states of affairs. As Anscombe (1971) puts it, "Causality consists in the derivativeness of an effect from its causes. This is the core, the common feature, of causality in its various kinds. Effects derive from, arise out of, come of, their causes" (6). On this view, to evaluate a causal hypothesis, one typically examines individual causal links that it posits, asking whether the putative causes would generate the observed effects. The process approach is thus relatively domain specific; it is sensitive to the identity and nature of the causes and effects in question. Versions of the view identify different processes that are constitutive or indicative of causal relations. For example, process theorists might ask whether there is a mechanism that connects A and B (Glennan 1996), whether A has the causal power to produce B (Mumford 2009), or whether the process linking A and B transmits a "mark" or conserves certain physical quantities (Salmon 1984). When the putative causes in question are agents, we might ask whether the agent's desire, A, would promote a certain action, B, or whether the agent has reasons that count in favor of B.

In contrast, a regularity account of causation sees causal relations as constituted by patterns of succession or correlation. To evaluate a causal hypothesis, one tests for patterns of probabilistic (in) dependence entailed by it. Knowledge of mechanism, causal powers, or physical processes is not necessary, though it may be helpful.

Regularity accounts also come in various flavors. For example, process theorists might ask whether there is a constant conjunction of A-type events and B-type events (Hume 1978) or whether there is a correlation between A and B (Reichenbach 1956). The regularity approach is much more domain-general, and it typically focuses on networks of causes rather than individual causal links.[2]

While there is evidence that Darwin's causal reasoning involved both process and regularity thinking, I will argue that he increasingly subscribed to a regularity account of causation and utilized regularity methodology in his defense of his theory.[3] While it would be anachronistic to attribute a sophisticated formal account of causation to Darwin, I suggest that we can make sense of some of Darwin's key arguments — including his argument from independence — using a regularity account that has been formulated much more rigorously in recent years.

This causal modeling framework represents causal hypotheses as causal graphs and uses patterns of probabilistic (in)dependence among events to infer causal relationships (Pearl 2009; Spirtes et al. 2000). This framework has generated an enormous philosophical and technical literature, but for our purposes, very simplified versions of its representational framework and inference principles will suffice.

A causal graph is a set of variables and causal arrows linking those variables, where the presence of an arrow denotes the presence of a direct causal link from A to B and the absence of an arrow denotes the lack of such a link. Causal links carry commitments about probability distributions, including (in)dependencies, over those variables. One tests a causal graph hypothesis by observing the frequencies with which variables take various states, inferring a probability distribution over the variables from those frequencies, and then finding the causal graphs that are consistent with those probability distributions.[4]

The basic rules linking probability distributions and causation are as follows. First, there is a rule that links probabilistic *dependency* to the *presence* of a causal relation. An early predecessor of today's rules is Reichenbach's Principle of the Common Cause: any probabilistic dependency between variables A and B is due to A causing B, B causing A, or a common cause, C, of both A and B. Today's Directed Acyclic Graph (DAG) formalisms typically use the Causal Markov Condition (CMC). Informally, the CMC states that if there is a causal arrow from A to B (and no other arrows into B), then conditional on the state of A, the state of B is independent of all other variables in the graph except for any variable C for which there is a directed causal path from B to C.[5] Hence, an event B's causal parents screen off all other variables from B, except for those that B causes. The second kind of rule links probabilistic *independence* to the *absence* of a causal relationship. The most common such rule is the Causal Faithfulness Condition (CFC): informally, if A and B are causally connected, then they will be probabilistically dependent (Weinberger 2018).

Here is a simple example. Suppose that we want to know what causes increases in the murder rate in a given city. We have observed correlations among temperature, ice cream sales, and the murder rate. None of these are correlated with the level of violence in music lyrics on the radio at the time. We can represent the variables below, where dashed lines indicate dependencies.

2. I do not want to overstate the difference between these two accounts, versions of which may overlap in their ontologies and recommended methodologies. Nevertheless, we can consider the process and regularity accounts to be rough families of approaches to uncovering causal relations.

3. Huntley (1972) argues that Darwin's thinking about causation was influenced by Hume's regularity account. For example, in *Variation* (1868), Darwin writes, "I mean by nature only the aggregate action and product of many natural laws, and by laws only the ascertained sequence of events" (Ch 7; quoted in Huntley 1972, 459).

4. Bayesian approaches to causal modeling use additional constraints to delimit the space of causal models (Griffiths and Tenenbaum 2009).

5. I am glossing over many of the technical details of the CMC which vary somewhat relative to the formal frameworks in which it is used. See Hausman and Woodward (1999), Spirtes et al. (2000), and Pearl (2009).

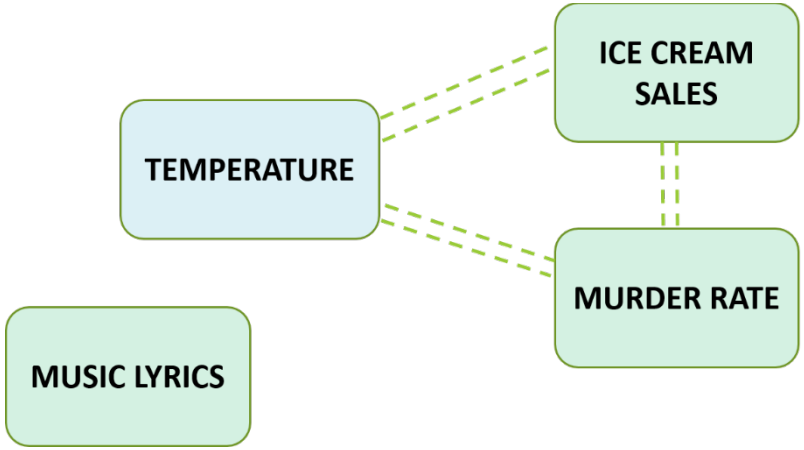

Figure 1. Probabilistic dependencies among variables.

Because music lyrics are not correlated with any other variables, CFC says that it is causally irrelevant to the murder rate. In contrast, the Principle of the Common Cause says that there is some causal relationship among temperature, ice cream sales, and murder. To figure out how these three variables are related, we can use the CMC. Suppose we find that if we hold temperature fixed, ice cream sales and the murder rate are no longer correlated; they are probabilistic independent conditional on the state of the temperature, yet each remains correlated with temperature. The CMC tells us that temperature is a common cause of ice cream sales and murder rates and there is no further causal link between them.

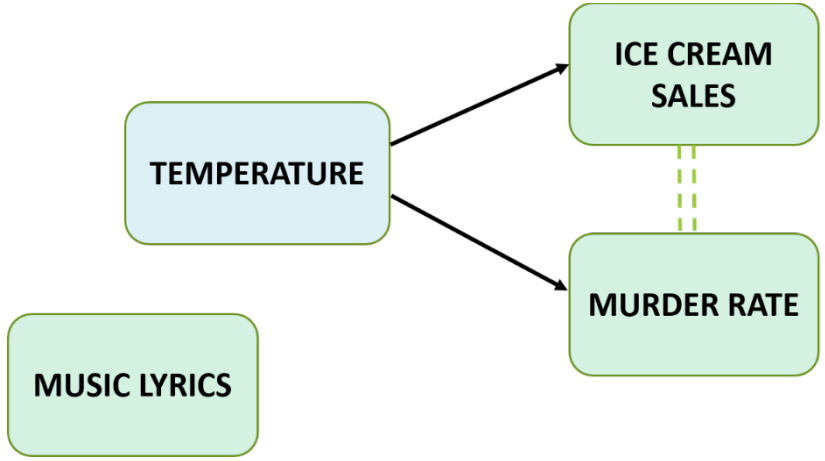

Figure 2. Inferred causal relationships among variables.

This last step, in which we tested for common causes by holding some causes fixed, needs a bit more elaboration. Intuitively, a common cause will screen off its effects from one another because the common cause carries all of the relevant information about its effects.[6] To preserve this intuition, we need to place extra conditions on how we hold fixed the common cause. In the causal modeling framework, an *intervention* is "a 'surgical' change in A which is of such a character that if any change occurs in B, it occurs only as a result of its causal connection, if any, to A and not in any other way. In other words, the change in B, if any, that is produced by the manipulation of A should be produced only via a causal route that goes through A" (Woodward 2016).[7]

6. Once you know the temperature, learning about ice cream sales won't tell you any more about the murder rate than you already know.

7. For example, suppose we want to know whether a drug causes death. If we deliver the medicine via shotgun blast, we will not have intervened in a way that tells us about the causal efficacy of the drug (Woodward 2003).

This informal presentation of the central insights and tools of causal modeling theory glosses over many of the technical details of a very complex literature. However, it should suffice to elucidate several historical debates over the causal structure of evolution, especially if, as I will argue, Darwin used many of these insights in his own thinking about causation.

3. The argument from imperfection

In the *Origin*, Darwin utilizes a diverse set of argumentative strategies to establish the existence of natural selection and common ancestry and their sufficiency to produce biological outcomes of interest. First, he followed standard scientific practice of the day by using Newton's (2003) *vera causae* methodology, first establishing artificial selection as a *vera causa* and then showing that the same type of cause is at work in natural populations (Hodge 1977, 1989, 1992; Hull 2009; Kavaloski 1974; Radick 2009). However, Darwin was aware that he had to do more to show that natural selection was the *actual* cause responsible for diversity and adaptedness, not just a possible one. The latter parts of the *Origin*, including his arguments from biogeography and embryology, are largely concerned with establishing that the natural world bears the signature of natural selection and common ancestry (Hodge 1977, 239). Of concern here are his direct arguments against the doctrine of special creation.

The defense and articulation of special creationism, which was front and center in the natural theological milieu of England in the 18th and 19th centuries, profoundly influenced and indeed convinced a youthful Darwin (Darwin 1887).[8] Darwin's primary target in the initial development of the *Origin* was the teleological (or utilitarian) argument for design, defended by mentors such as Whewell and Sedgwick and exemplified by texts by Paley (1819a, 1819b) and the Bridgewater treatises written by Whewell (1833) and Bell (1833).[9] Though Darwin later shifted his attention to alternative creationist views that made their way to England in the 1840s–50s, it is appropriate to start with those earlier teleologists, as "the creative Darwin was a man of the 1830s rather than the 1850s" (Ruse 1979, 184).[10]

3.1 The teleological view

While some variety can be found among teleological special creationist views, its central commitments are that (i) each species, in roughly its current form, was the result of a distinct act of creation, and (ii) the traits of each species were specially designed to fulfill some purpose. For example, Bell (1833) argued that "every change has been for a purpose, and every part has had its just relation" (quoted in Beatty 2006, 636). We might call these two commitments about the creative process *distinctness* and *teleology*. The causal model posited by special creationism is depicted below, wherein each biological species and trait is caused by separate purposeful actions by the Designer ("God's purposive action," or GPA for short):

8. Darwin was especially taken by Paley's *Evidences of Christianity*, published in 1794 (Darwin 1887). Ruse (1979) surmises that Darwin "could have written out the whole of the *Evidences* with perfect correctness" (65).

9. This time period also was marked by a proliferation of nontheistic, non-Darwinian evolutionary accounts, such as those from Lamarck and Erasmus Darwin (Rupke 2005). I will be focused on the debate between Darwin and creationists of various stripes, so I will ignore these views here.

10. In the "Historical Sketch" appended to the first (1860) American version of the *Origin*, Darwin briefly lists previous evolutionary or proto-evolutionary thinkers. In it, we find some evidence of his intellectual background (Johnson 2007). He claims that "the great majority of naturalists have believed that species were immutable productions and have been separately created.... Passing over authors from the classical period to that of Buffon with whose writings I am not familiar, Lamarck was the first man whose conclusions excited much attention on this subject." There is little mention of Continental naturalists in the morphological tradition, though these would be added in later editions of the *Origin* (Johnson 2019).

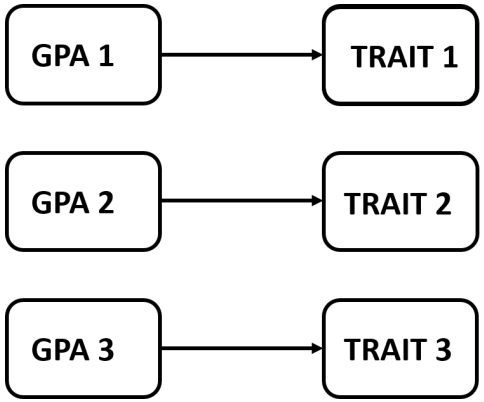

Figure 3. The causal model posited by special creationism, on which each trait is caused by distinct purposive actions of God (GPA).

One way to evaluate the plausibility of this hypothesis is via a process approach: for any putative causal relationship, we may ask whether the posited causes exist and whether they would promote, produce, or raise the probability of its effects. In this case, we may ask whether God's putative purposes would make the traits we observe likely and whether other candidate causes would as well.

We can cast Paley's (1819b) famous argument from design in these terms. Many biological traits, such as the eye, have a function and are delicate — that is, they have parts that are arranged so as to perform that function, where disruptions of this complex arrangement would lead it to cease functioning (Sober 2008, 2018). Paley compared two hypotheses for how these came about: either by chance collisions of matter or through the purposive action of a Designer. If a trait resulted from mere chance, neither its function nor the careful arrangement of its parts is to be expected; blind chance can't have reasons for "preferring" one outcome over any other, and so it is exceedingly unlikely that the precise arrangement we see would have resulted from random chance. Furthermore, because chance does not have foresight, it could

not have purposefully arranged parts in the correct order to achieve correct functioning. However, designers do have reasons for making objects that play some useful function, and they have foresight. Hence, a trait's having a clear function, and parts arranged so as to perform that function, is evidence of its having been designed for that purpose.

Paley's argument is represented in the diagram below, where chance makes complex functioning traits less probable and the purposeful action of a designer promotes them:

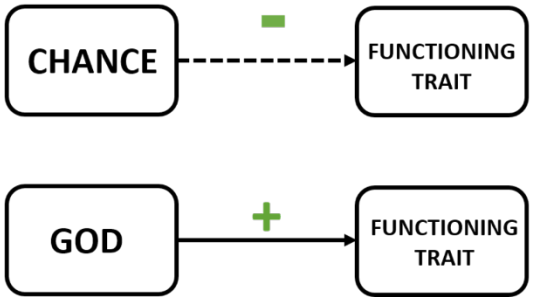

Figure 4. Graph depicting claim that chance makes observed traits less probable, whereas God's purposive action (GPA) makes them more probable.

One of the chief rejoinders to Paley's argument is what we might call the argument from imperfection or the "no designer worth his salt" objection (Radick 2005). This argument grants that traits that function well and are delicate are evidence of design. However, if this is so, then traits that function poorly (or not at all) or whose parts are not carefully arranged to perform that function should be evidence against design. These latter traits are abundant, and creationism's critics can pick their favorite examples: the panda's thumb (Gould 1980), the laryngeal nerve (Coyne 2009; Dawkins 2009), and so forth.

While modern versions of the argument from imperfection typically

identify traits that have a function but whose design is not optimized for that function, Darwin instead points to traits that either have no function at all or appear to satisfy a function that is useless in their current milieu. In his section on "rudimentary, atrophied, and aborted organs" in Chapter 13 of the *Origin,* Darwin presents a list of such traits and argues that they would be unlikely outcomes of design: "on the view of each organic being and each separate organ having been specially created, how utterly inexplicable it is that parts, like the teeth in the embryonic calf or like the shriveled wings under the soldered wing-covers of some beetles, should thus so frequently bear the plain stamp of inutility!" (1859, 480).

In contrast, Darwin can easily explain the existence of such traits as having been inherited from an ancestor, for whom they played some important function. He buttresses his argument by pointing to traits that are quite clearly structured to play a particular function despite the fact that their current bearers have no use for them:

> He who believes that each being has been created as we now see it, must occasionally have felt surprise when he has met with an animal having habits and structure not in agreement. What can be plainer than that the webbed feet of ducks and geese are formed for swimming? Yet there are upland geese with webbed feet which rarely go near the water…. But on the view of each species constantly trying to increase in number, with natural selection always ready to adapt the slowly varying descendants of each to any unoccupied or ill-occupied place in nature, these facts cease to be strange, or perhaps might even have been anticipated. (*ibid.*, 471)

Like Paley, Darwin's approach here is to evaluate the plausibility of posited causal links. He argues that while natural selection and common ancestry would promote functionless traits, God's purposive action would make them less probable:

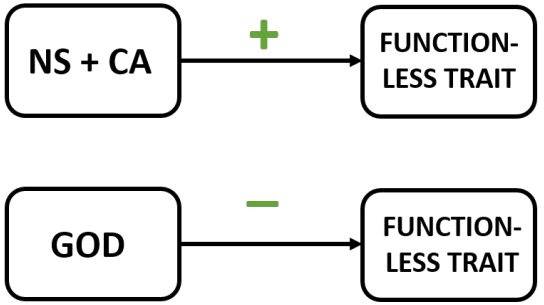

Figure 5. The causal model posited by the argument from imperfection. Natural selection and common ancestry (NS+CA) makes imperfect traits more probable, and God's purposive action (GPA) makes imperfect traits less probable.

The argument from imperfection is predicated on the claim that if function and delicacy are evidence of design, then a lack of function should be evidence against it. In order for this argument to work, the following assumptions must hold:

> (a) If special creationism is true, traits will (probably) have functions.
>
> (b) If special creationism is true, there will (probably) be fitting of traits to current purposes.
>
> (c) There are functionless or mismatched traits.

Unfortunately, Darwin expresses doubts about each of these assumptions in the *Origin*, which might explain his ambivalence about the argument from imperfection.

With respect to (c), Darwin frequently argues that our *a priori* judgments about traits and their functions are unreliable, thus undermining our ability to know whether a trait is indeed functionless or poorly "designed" for that function. In a section on "organs of little apparent

importance," he considers seemingly trifling traits, such as the "fly-flapper" tails of giraffes or the downy fuzz of a peach, which might serve as evidence against his theory, since these traits would not confer a survival and reproduction advantage on their bearers. He shows that some of these traits do in fact confer a significant advantage and cautions that "in the first place, we are much too ignorant, in regard to the whole economy of any one organic being, to say what slight modifications would be of importance or not" (1859, 206). If this is so, then can we justifiably assert that the panda's thumb is imperfect or that the snake's leg bones serve no purpose?

Darwin's doubts about (a) and (b) stem from Darwin's own views about the unknowability of an omnipotent designer as well as special creationist views that specifically eschew these assumptions (*ibid*., 193). For example, creationists sometimes argued against Darwin's theory precisely by arguing that some traits, such as the peacock's tail, were functionless and indeed detrimental. These traits can be explained on the hypothesis of special creation, they argued, if we do not assume that a benevolent designer would only be motivated to give creatures traits that would be good for their survival. God may have designed the peacock's tail for its beauty, for the edification of himself or other creatures. Darwin describes the view in his *Orchids* book thus:

> Some naturalists believe that numberless structures have been created for the sake of mere variety and beauty … that such useless organs were not remnants retained by the principle of inheritance at corresponding periods of early growth, but were specially created and arranged in their proper places like dishes on a table by an Omnipotent hand "to complete the scheme of nature." (1862, 244)[11]

While he cannot disprove this view, Darwin is dismissive of it, arguing that some hypothesize that the Designer creates "for 'the sake of symmetry' or 'to complete the scheme of nature'; but this seems to be no explanation, merely a restatement of fact" (1859, 452).

Darwin's doubts about (b) stem from creationist views that reject the naïve teleological argument for design, to which we will now turn.

3.2. The morphological view

It was long known that traits used for very different purposes, such as the forelimbs of humans, monkeys, bats, and whales, bore striking similarities of structure, which would undermine the claim that each trait was individually and separately created for their purposes. In causal modeling terms, special creationism predicts that traits should be independent when God's purported purposive acts are independent. Hence, these correlations among traits are not accounted for on the special creationist hypothesis of Paley, Whewell, and the like, for "from a *strictly* teleological point of view, similarities and differences in form should reflect similarities and differences in the uses served" (Beatty 2006, 636).

Darwin's collaborator and occasional antagonist, Richard Owen, argued against the teleological argument for design on the basis of homologies across organisms and among parts of individual organisms.[12] In his *On the Nature of Limbs*, Owen painstakingly argues for similarities among vertebrates that do not reflect differences in function. Furthermore, some traits appear to lack function entirely.[13] For example, in the horse's hoof, "the carpal series of small bones answers almost exactly, bone for bone, to that in man" despite the fact that "almost all

11. Whewell (1833) is Darwin's likely target here.

12. For a discussion of Owen's morphological predecessors in England, see Bowler (1977) and Amundson (2005).

13. Owen also denied that we can discern the function of traits by examining them *a priori* and in isolation. He gives the example of skull sutures in mammals, which were postulated to have the function of enabling passage through the birth canal. However, he notes that these sutures are found in birds and kangaroos, neither of which would need them for birth (1849, 40). This very same argument was adopted, and given a phylogenetic justification, by Darwin (1859, 197).

that the hoof can be made to do is rest upon or beat against the ground" (1849, 11–12).[14]

Homologies would be surprising if *distinctness* and *teleology* are true. As Owen argues:

> Nor should we anticipate, if animated in our researches by the quest of final causes in the belief that they were the sole governing principle of organization, a much greater amount of conformity in the construction of the natural instruments by means of which those different elements are traversed by different animals. The teleologist would rather expect to find the same direct and purposive adaptation of the limb to its office as in the machine. (*ibid.*, 10)

According to the morphological (or structural) approach,[15] organismal traits result from the interplay of two forces: the unity of plan that underlies all organisms of a type and a polarizing force that would "subdue and mould it in subserviency to the exigencies of the resulting specific forms" (1848, 172). The unity of type is captured by the archetype, variously described by Owen as the *Bedeutung*, essence, Platonic idea, or predetermined pattern for a given part, "that essentiality which it retains under every modification of size and form, and for whatever office such modifications may adapt it" (*ibid.*, 2–3).[16]

14. Interestingly, finding no extant organisms that seem to establish a link between the horse hoof and cloven-hoofed animals, Owen suggests that "the extinct Palaeotherium offers a connecting link in the transition to the apparently monodactyle foot" (1849, 137).

15. For a history of the morphological approach and its Romantic origins, see Ruse (1979). For a discussion of the influence of the morphological approach on Darwin's development of his positive arguments in the *Origin*, see Amundson (2005).

16. The ontological status of the archetype — from theoretical abstraction to actual divine plan — seems to have changed across Owen's work in the 1840s (Lowther 2013; Rupke 1993). Likewise, Owen is not clear about what kinds of secondary forces adapt the archetype to its specific uses (1849, 86). On this latter point, see MacLeod (1965).

Though Owen posits a different process of creation, he maintains that "the Divine mind which planned the Archetype also foreknew all its modifications" (*ibid.*, 86). Hence, a special creationist design hypothesis need not posit a one-to-one matching between form and function. God, in his simplicity and unity, creates from a general archetype (e.g., the vertebrate limb) which is altered for the idiosyncratic needs of each species, and this unity of plan explains both rudiments and homologies. We can model Owen's view as follows, where the introduction of the archetype as an intervening cause accounts for the correlations among traits and the adaptative force explains their differences.

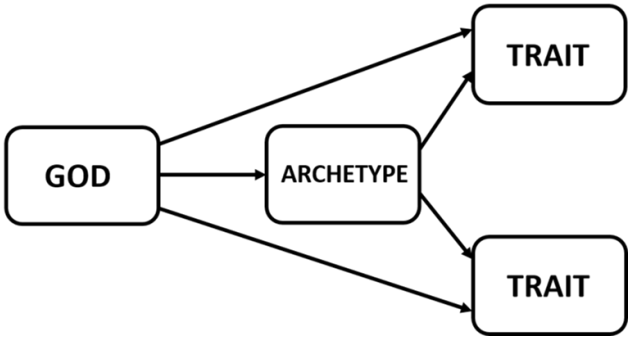

Figure 6. The causal model posited by Owen's archetype theory.

Creationism, then, proved to be a more flexible theory than first thought, able to accommodate both outcomes thought unlikely (functionless traits) and various means through which God creates. Instead of denying creationism's compatibility with all observations, Darwin instead pulls a jujitsu maneuver, leveraging creationism's flexibility into a powerful argument against it.

3.3 Explanatory vacuity

Consider again how special creationists explain a seemingly functionless trait, such as the peacock's tail. If we assume that the Designer intends to give creatures traits that are useful to them, then God's purposive action would make functionless traits unlikely. However, by changing their assumptions about God's intentions, the creationist can show that this outcome was probable:

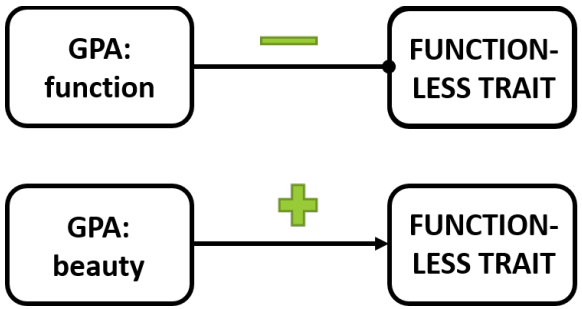

Figure 7. If God's purposive action (GPA) is assumed to promote function, then it makes the trait improbable. If GPA is assumed to promote beauty, then it makes the trait probable.

Indeed, by changing their assumptions about the designer, the creationist can make their theory compatible with any observation at all. If each act of creation is distinct, the creationist can adjust individual causal links to accommodate traits piecemeal. By changing their assumptions about how God creates, creationists like Owen could make the design hypothesis compatible with dependencies among traits as well. Lastly, we cannot independently test these changed assumptions since we do not know what the designer's goals are (Darwin 1859, 193).

As philosophers of science have long argued (e.g., Popper 1959), a theory that is compatible with any possible data places no restrictions on what the world should be and makes no predictions. This worry about the design hypothesis is referred to as the Preference Problem (Sober 2008; White 2007): in order to predict what we would observe if the design hypothesis were true, we first need to know what the designer's goals and capacities are. Unless there is some state of affairs that *any* designer would be likely to create, "the" design hypothesis only makes predictions if it sticks its neck out as to the nature of the designer.

For Darwin, creationism's accommodationist turn renders it explanatorily vacuous. Darwin asserts in the *Origin* that "on the ordinary view of the independent creation of each being, we can only say that so it is — that it has so pleased the Creator to construct each animal and plant" (1859, 435) and more forcefully in a letter to Gray that "to say that species were created so & so is no scientific explanation, only a reverent way of saying it is so & so" (July 20, 1857).

Hence, Darwin is faced with a dialectical dilemma in his attack on special creationism. On the one hand, functionless traits seem to provide evidence against design. On the other, it doesn't seem like there could be any real evidence against design given its slippery accommodation of any possible observation. In the parlance of 20th-century philosophy of science, Darwin seems to vacillate between the view that the hypothesis of special creation has been falsified and the view that the hypothesis of special creation is unfalsifiable. As Laudan (1982) forcefully notes, these two positions are in conflict if not downright contradictory.[17]

4. Theistic evolution

The explanatory vacuity of special creationism arises from two commitments. First, at least for the canonical version of the view, since each act of creation is presumed to be independent of all others, the variables in the model and the relations among them can all be adjusted without constraint. Second, God's purposes and the means through

17. Darwin could make them compatible by arguing for a disjunction: either the view takes a stance about the nature of the designer and is false, or it doesn't and is untestable. Thank you to a reviewer for pressing this point.

which he creates are assumed to be, if not totally inscrutable, at least immune from direct, independent testing.

By rejecting the first commitment, if not the second, we arrive at a version of creationism — theistic evolution — that evades both of Darwin's criticisms (i.e., imperfect traits and explanatory vacuity). Just as deism proposes that God set matter and the laws of nature in place and then does not intervene in their workings, theistic evolution (without divine intervention) posits that God designed species and their traits via the laws of evolution by natural selection.[18]

In a sense, this view is part of a consistent trajectory from the teleologist through the morphological approach to creationism. When faced with homologies, creationists were driven to posit intervening causes to establish probabilistic dependencies among traits. Sound regularity thinking led creationists to adopt a model with a structure much like the evolutionary one, though their interpretation of the causal variables and arrows differed.[19]

Hence, it was possible for Darwin to co-opt rather than refute structuralist hypotheses. The archetype, a common plan from which species are individually adjusted, can be quite naturally reinterpreted as an actually existing common ancestor rather than a mere idea; hence, "the vertebrate archetype provided a direct stepping-stone to the notion of evolutionary ancestors" (Rupke 1993, 231). A theory of secondary causes leading to diversification and adaptation, about which Owen remained agnostic, can be filled in with natural selection.[20] Thus, Darwin argued that his theory can provide a unified account of both of Owen's forces:

> It is generally acknowledged that all organic beings have been formed on two great laws: Unity of Type, and the Conditions of Existence. By unity of type is meant that fundamental agreement in structure which we see in organic beings of the same class, and which is quite independent of their habits of life. On my theory, unity of type is explained by unity of descent. The expression of conditions of existence, so often insisted on by the illustrious Cuvier, is fully embraced by the principle of natural selection. For natural selection acts by either now adapting the varying parts of each being to its organic and inorganic conditions of life; or by having adapted them during past periods of time: the adaptations being aided in many cases by the increased use or disuse of parts, being affected by the direct action of the external conditions of life, and subjected in all cases to the several laws of growth and variation. Hence, in fact, the law of the Conditions of Existence is the higher law; as it includes, through the inheritance of former variations and adaptations, that of Unity of Type. (1859, 206)

In the *Origin*, Darwin seems to have settled somewhere between endorsement of and agnosticism about theistic creationism. Gray, by contrast, enthusiastically defended the theistic interpretation of Darwin's theory in a series of widely read reviews of the *Origin* (republished in Gray 1876). We can model the theory as follows:

18. In Section 9, I will consider an alternative theory of theistic creationism on which God both creates the laws of evolution and occasionally directly intervenes to bring about favored traits.

19. See Amundson (2005, Ch. 4) for a discussion of how morphological/structuralist thinking influenced Darwin in his development of the *Origin*. He notes that "although it is true that Darwin respected and used the morphological and embryological results from the structuralist biologists, he was not a structuralist himself" (102).

20. The main difference between Darwin's and Owen's theories concerned the contingency of the secondary causes. See Beatty (2006) and Camardi (2001) for discussion. Darwin's arguments against Owen's view are similar to the argument from independence but cannot be addressed fully here.

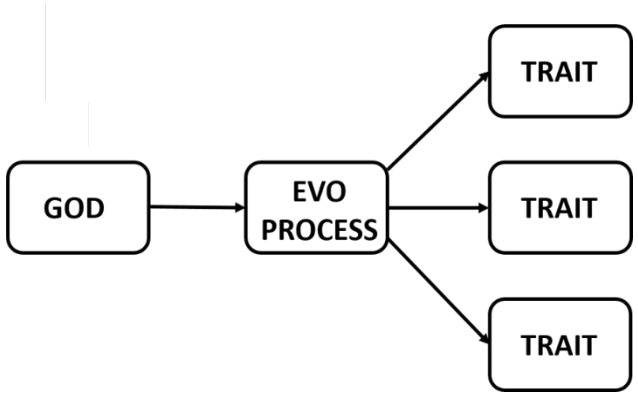

Figure 8. The causal model posited by theistic evolution without intervention.

This view preserves the status of God as a designer while capturing all of the explanatory benefits and predictive power of Darwin's theory of evolution. The laws of evolution unify God's creative activities in a way that avoids the problem of accommodationism. Since the evolutionary process is responsible for extant traits, it can explain their seeming imperfections. If archetypes are recast as common ancestors, then we can hope for empirical access to them via the fossil record. More broadly, the evidence Darwin provides for his theory (the right-hand part of the diagram) is silent with respect to what is causally upstream from the evolutionary laws. The CMC supports this claim; since the evolutionary process screens off all prior causes, adding God to the causal model above makes no difference for the outcomes of evolution.

The plausibility of theistic evolution thus depends on the following: Could and would God create via evolutionary laws? Would the resulting traits genuinely count as *designed*? With respect to the first question, we may first ask whether God would design via intermediary natural laws at all. Darwin is clearly on the side of yes, arguing that "it accords better with what we know of the laws impressed on matter by the Creator, that the production and extinction of the past and present inhabitants of the world should have been due to secondary causes, like those determining the birth and death of the individual" (1859, 488). Likewise, Gray argues that the scientific investigation of secondary causes need not affect philosophical or theological claims about primary causes (1876, 138). He points out that even the staunchest special creationist has to either admit of creation via secondary causes (e.g., the causes that guide development from an embryo to a human adult) or to deny the distinction between primary and secondary causes entirely (e.g., a version of occasionalism) (*ibid*., 159).

Furthermore, Gray argues that creation via the means of secondary laws does not preclude the outcomes of those laws from being designed. A watchmaker may create watches by painstakingly building each by hand, or he may create by designing a machine that mass-produces his watches, and they are equally products of his design.[21]. Gray concludes that "the adoption of a derivative hypothesis, and of Darwin's particular hypothesis, if we understand it, would leave the doctrines of final causes, utility, and special design, just where they were before…. [H]is hypothesis concerns the *order* and not the *cause*, the *how* and not the *why* of the phenomena" (*ibid*., 145, 149).

The question of whether God would or could design via *this particular set of laws*, the evolutionary ones, is somewhat more fraught, and it is here that the seeds of subsequent disagreement were planted. On the one hand, the concluding chapter of the *Origin* speaks to the theological tenability of theistic evolution:

> A celebrated author and divine has written to me that "he has gradually learnt to see that it is just as noble a conception of the Deity to believe that He created a few original forms capable of self-development into other and needful forms, as to believe that He required a fresh act of

21. Paley also maintained that secondary causes are compatible with design; see Shapiro (2009).

> creation to supply the voids caused by the action of His laws." (1859, 480, quoting letter from Charles Kingsley, November 18, 1859)

On the other hand, Darwin expressed a growing discomfort with the notion of an omnipotent, omnibenevolent God who designs via a process that essentially involves the large-scale death and destruction of sentient beings:

> I own that I cannot see as plainly as others do, and as I should wish to do, evidence of design and beneficence on all sides of us. There seems to me too much misery in the world. I cannot persuade myself that a beneficent and omnipotent God would have designedly created the *Ichneumonidae* with the express intention of their feeding within the living bodies of Caterpillars, or that a cat should play with mice. (letter to Asa Gray, May 22, 1860)

In the subsequent decades, Darwin would move away from agnosticism about theistic evolution. However, his reasons for doing so extend beyond his concerns about the problem of evil. Indeed, it was through a debate with Gray about the nature of the evolutionary process itself that Darwin developed a new argument against design.

5. The argument from independence

5.1. Guided variation

Though Gray argued that intervening secondary causes, including evolutionary ones, need not impede the inference to design, he did not maintain that just *any* such secondary causes would be compatible with theism. He deemed atheistic any theory according to which "the natural causes through which species are diversified operate without an ordaining and directing intelligence, and that the orderly arrangements and admirable adaptations we see all around us are fortuitous or blind, undesigned results — that the eye, though it came to see, was not designed for seeing, nor the hand for handling" (1876, 146).

More specifically, the positing of chance or randomness in evolution would be anathema to design: "Nature is a result of design or of chance. Variation and natural selection open no third alternative; they concern only the question how the results, whether fortuitous or designed, may have been brought about" (*ibid.*, 151). Here we find two points that are important for an assessment of theistic creationism. The first is that the depiction of the theory in Figure 8 is somewhat misleading. The "evolutionary process" is not a single causal factor but instead a combination of *natural selection* and *variation*. Hence, we can now depict theistic evolution more precisely as follows:

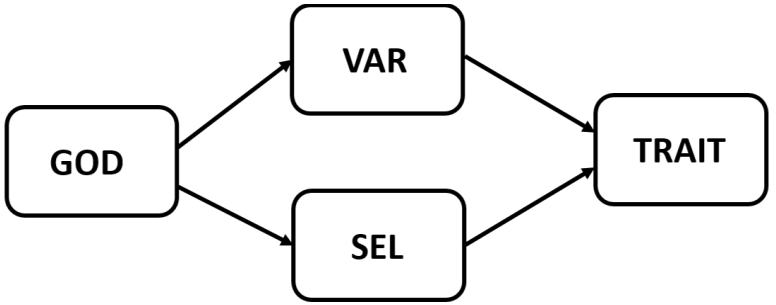

Figure 9. An expanded causal model of theistic evolution.

Second, Gray argues that theistic evolution is untenable if variation and selection are *chancy*. On his theory, the outcomes of evolution are designed because variation is guided. Here, Gray exploits one of the major lacunae of Darwin's theory; at this juncture, Gray fairly alleges that "though natural selection is scientifically explicable, variation is not" (*ibid.*, 157).[22] It is into this gap that Gray inserts God's creative activity:

22. As Tabb (2016) puts it, "Variation was for Darwin inexplicable, and by locating intelligence at the origin of this mysterious force, Gray succeeded in assigning God a role without disturbing the more basic tenet of Darwinian theory: the preservation of some variations over others" (18).

> Wherefore, so long as gradated, orderly, and adapted forms in Nature argue design, and at least while the physical cause of variation is utterly unknown and mysterious, we should advise Mr. Darwin to assume, in the philosophy of his hypothesis, that variation has been led along certain beneficial lines. Streams flowing over a sloping plain by gravitation (here the counterpart of natural selection) may have worn their actual channels as they flowed; yet their particular courses may have been assigned; and where we see them forming definite and useful lines of irrigation, after a manner unaccountable on the laws of gravitation and dynamics, we should believe that the distribution was designed. (*ibid.*, 121–122)

A stream flowing downhill obeys the laws of gravitation, though the particular course it takes is left open by those laws. Likewise, selection will lead species to greater fitness, though the particular course they take through state space is left open by its laws. By manipulating the sources of variation, God can drag his finger across the state space, guiding species toward certain favored ends. Hence, variation and the outcomes of evolution are due to design, not chance.

5.2 A morass of chance concepts

Whether variation is indeed chancy and whether chance is mutually exclusive from design depends crucially on what is meant by "chance." Writing at the inception of the probabilistic revolution in biology, Darwin and Gray puzzled through a morass of chance concepts (Beatty 2006; Lennox 2010). At varying points in their exchange, chance is conceived of as:[23]

1. Uncaused: to say any outcome is due to chance is to say that it is uncaused

23. I will argue that Darwin should be credited with the development of another conception of chance — chance as causal independence — which was the crux of his decisive (to him) argument against theistic evolution.

2. Unlawlike

3. Unpredictable or unknowable

4. Not designed for some goal

5. Unbiased: each possible outcome of a chance process is equally probable

6. Mathematical probability

As we have seen, Gray believed chance and design to be mutually exclusive and exhaustive hypotheses. In order to develop the best version of his argument, we may ask which conception of chance listed above would support this view. Clearly, (3) will not suffice, as something can be unpredictable to humans yet the result of God's design. Gray is sometimes more sympathetic to (1) or (2), maintaining that as "chance carries no probabilities with it, [and] can never be developed into a consistent system" (1876, 153). However, he retreats from this position, admitting that even if science were to discover the causes or laws of variation, this would be "still just another chain of secondary causes" compatible with design (157).

At times, Gray formulates his argument via conception (5), arguing that variation is chancy if it is not biased toward favorable outcomes: "It is evident that the strongest point against the compatibility of Darwin's hypothesis with design in Nature is made when natural selection is referred to as picking out those variations which are improvements from a vast number which are not improvements, but perhaps the contrary, and therefore useless or purposeless, and born to perish" (*ibid.*, 156). Perhaps, then, theistic evolutionists are committed to the claim that the probability of beneficial variations is greater than some threshold (say, .5). Gray must have been aware that this version of the argument was untenable, for the majority of variations are injurious rather than beneficial. He weakens his position, maintaining that beneficial variations need not be in the majority for there to be design. By analogy, most raindrops fall on the ocean, yet "does it therefore follow

that the rains which are bestowed upon the soil with such rule and average regularity were not designed to support vegetable or animal life?" (*ibid*., 157).

Gray allows that the chance hypothesis is compatible with variations being caused in a lawlike fashion, and the design hypothesis is compatible with variations being unpredictable and beneficial variations rare. What, then, is left of Gray's theory of guided variations? Perhaps Gray's position is that variation is due to chance, rather than design, if the variations that arise are *random with respect to* what would be beneficial for their possessors. That is, the probability of a variation arising is independent of the probability that it would be selectively beneficial.

Indeed, this is typically how biologists today conceive of the claim that mutation is random (Lenski and Mittler 1993; Luria and Delbrück 1943; Sober 2011): mutations are independent with respect to fitness iff Pr(mutation x|x would be fit) = Pr(mutation x|x would be unfit). For illustration, consider the following hypothetical experiment (Sober 2011). Suppose that there is a population of bacteria that can undergo mutations for green or red coloration and that there is selection for coloration that matches the background substrate.[24] The population is stamped onto one green background and one red one, creating clones of the original population. We then observe the rate at which green and red mutations occur. If variation is independent of selection, we expect that the probability of a green mutation is identical in both daughter populations — Pr(green mutation|green is fit) = Pr(green mutation|red is fit) — and likewise for red. If we observed that green mutations were more frequent in green backgrounds than in red ones, or vice versa, this would be evidence that mutations were biased toward traits that are fit.

Note that the independence hypothesis is consistent with green mutations being much more probable than red ones. Even if we observe trends toward certain outcomes, like green coloration, this unconditional frequency fact does not suffice to evaluate variation's chanciness. Hence, observations of overall trends or frequencies of variation leave open the possibility that variation is biased or unbiased toward favorable outcomes. To evaluate the chance hypothesis, we need to compare the probabilities of variations *conditional on selective environments*. However, if we accept Darwin's arguments from Section 3 that it is difficult for us to tell which traits are indeed fit, then it will also be difficult to evaluate these conditional probabilities from observations of evolved populations.

The way in which experimenters determine these conditional probabilities is by manipulating the background selective environment and observing whether this has any effect on the probability of variation. Darwin grasped this point and leveraged it into the argument from independence.

6. The argument from independence — Premise 1

A first pass at the argument from independence is as follows:

> 1. Variation is random with respect to fitness.
>
> 2. If the outcomes of evolution were designed, then variation would not be random with respect to fitness.
>
> C: Therefore, the outcomes of evolution are not designed.

In this section, I will examine Darwin's evidence for Premise 1. In the next, I will consider Darwin's and Gray's support for Premise 2.

In a series of letters in early 1860, Darwin notes his deep appreciation for Gray's reviews of the *Origin* and begins to ruminate on their theological content. The opening salvo of his argument from independence comes in a letter to Gray on November 26:

> You lead me to infer that you believe "that variation has been led along certain beneficial lines." I cannot believe this; & I think you would have to believe, that the tail of

24. The actual experiments that provided persuasive evidence that mutation is unbiased were significantly more complex, though the basic logic is the same (Luria and Delbrück 1943).

> the Fan-tail was led to vary in the number & direction of its feathers in order to gratify the caprice of a few men. Yet if the fan-tail had been a wild bird & had used its abnormal tail for some special end, as to sail before the wind, unlike other birds, everyone would have said what beautiful & designed adaptation. Again I say I am, & shall ever remain, in a hopeless muddle.

Darwin's reference to pigeon fanciers shows his typical reliance on artificial selection as a *vera causa* of evolution, one which is much more transparent to our analysis than natural selection. Here, it provides controlled manipulations of the selective environment which Darwin uses to establish the randomness of variation.

Suppose that a pigeon fancier starts with a population of pigeons with moderately sized beaks. The breeder, if desired, could start selecting for shorter beaks. Should the breeder "wish to obtain a breed thus characterized, he would succeed in a surprisingly short time by careful selection" (1868, 423). If the same breeder changed course, now desiring longer beaks, he could reverse the direction of selection and successfully change the population in the other direction. Alternatively, if we imagine two different breeders starting with identical populations of pigeons but with divergent interests, "the two lots would ultimately come to differ" (*ibid.*, 424). This divergence of selective environments in fact led to such diverse creations as the short-faced tumbler and English carrier pigeon.[25] Examining the history of artificial selection, Darwin notes:

> It matters not under what climate, or for what purpose they are kept, whether as food for man or beast, for draught or hunting, for clothing or mere pleasure,—under all these circumstances races have been produced which differ more from one another than do the forms which in a state of nature are ranked as different species….
>
> The fluctuating, and, as far as we can judge, never-ending variability of our domesticated productions,—the plasticity of almost their whole organization,—is one of the most important lessons. (*ibid.*, 406)

The point here is that if variation were predetermined toward the Designer's favored ends, then artificial selection would only work when aligned with those predetermined directions. However, we observe that artificial selection can push the very same ancestral population toward whichever ends breeders happen to fancy.

One might object that Darwin's observations do not suffice to prove probabilistic independence, for perhaps breeders are fighting an uphill battle in pushing populations in certain directions against the Designer's will. However, Darwin argues that we do not have any evidence for this possibility; for example, breeders have produced long- and short-beaked pigeons, greyhounds, and turnspit dogs with equal facility.[26] One might also object that there is some preestablished harmony between God's and breeders' intentions, that God created those variations that breeders would later desire. Darwin dismisses this for several reasons. First, artificial selection has not only created variations that create greater crop yields or healthier livestock. It has also created bulldogs renowned for their viciousness and pouter pigeons so deformed that they are flightless. Second, the selective environment is manipulated by an act of free will of the breeder, which should constitute a genuine intervention on selection. That is, artificial selection has the causal structure in Figure 10, not Figure 11.

25. Darwin suggests that the divergence of traits under the hand of breeders with divergent interests serves as a *vera causa* for the law of divergence of character (1868, 423).

26. I will return to this objection in Section 9.

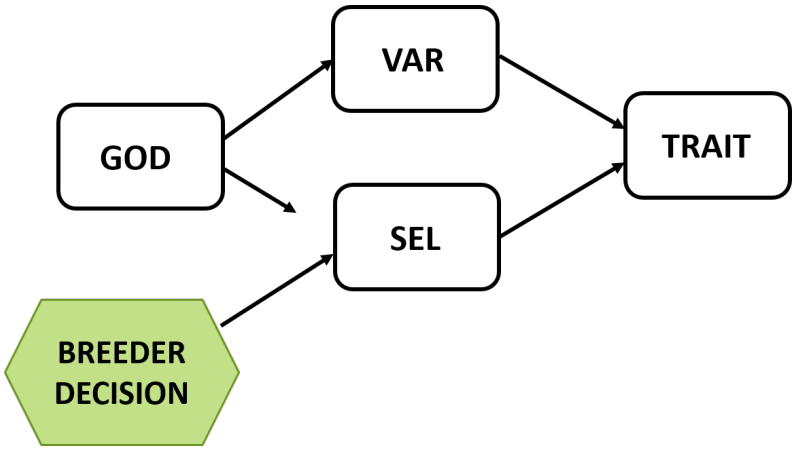

Figure 10. A causal model of artificial selection, with the breeder's decision constituting a genuine intervention on selection.

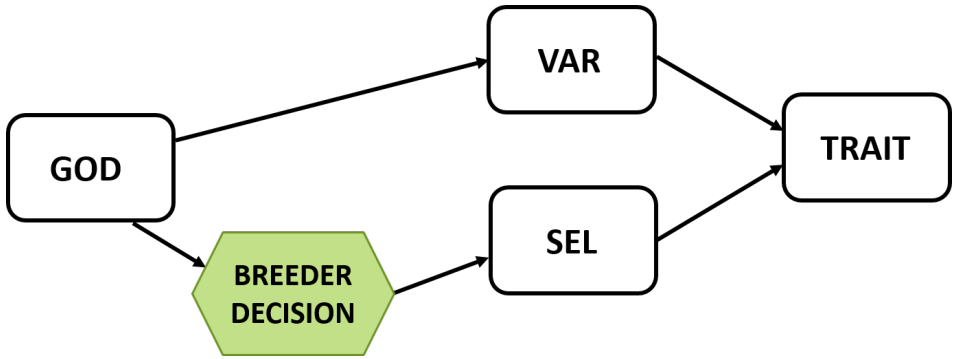

Figure 11. A causal model of artificial selection, with the breeder's decision not constituting a genuine intervention on selection.

To reiterate, if Figure 10 describes the correct causal structure of artificial selection, then the breeder's decision constitutes a genuine intervention on the system. By manipulating the selective environment, the breeder can change the value of the resultant trait.[27] This should not be possible if variation is strongly biased toward selective outcomes. Darwin completes his analogy between artificial and natural selection in an early letter to Henry Wentworth Acland:

> I cannot believe that any one structure is expressly designed, in the common meaning of the word. Asa Gray, who believes in Nat. Selection, believes that the initial variations are designed, but he could not maintain that the variations of domestic animals, such as those by which the Pouter pigeon has been formed, were expressly designed; nor did he dispute that the variations under domestication & under nature are of the same order & follow the same laws. (December 8, 1865)

Darwin presents his final version of the argument from independence through his famous metaphor of the architect.[28] Imagine a stone wall made up of heterogeneously shaped rocks, fit tightly together. Though the wall has a function and has parts elegantly put together to achieve that end, the stones that make up the wall were not shaped by the architect to fit together. Instead, the architect selected from the available stones, presumably discarding many, to achieve such a fit:

> The shape of the fragments of stone at the base of our precipice may be called accidental, but this is not strictly correct; for the shape of each depends on a long sequence of events, all obeying natural laws…. But in regard to the

27. Darwin also argues that breeders can hold selection fixed and intervene on variation by increasing or decreasing population sizes or changing their "conditions of life" (1868).

28. For an excellent history of the development of this metaphor, and its relationship to Darwin's thinking about free will and predestination, see Noguera-Solano (2013).

use to which the fragments may be put, their shape may be strictly said to be accidental….

If the various laws which have determined the shape of each fragment were not predetermined for the builder's sake, can it be maintained with any greater probability that He specially ordained for the sake of the breeder each of the innumerable variations in our domestic animals and plants; — many of these variations being of no service to man, and not beneficial, far more often injurious, to the creatures themselves?

If we give up the principle in one case, — if we do not admit that the variations of the primeval dog were intentionally guided in order that the greyhound might be formed, — no shadow of reason can be assigned for the belief that variations, alike in nature and the result of the same general laws … were intentionally and specifically guided. (1868, 431–432)

7. The argument from independence — Premise 2

So much for Darwin's defense of Premise 1 of the argument from independence. What is his argument for Premise 2, that if the outcomes of evolution were designed, then variation would not be random with respect to fitness? Would such an argument evade the problems that beset the argument from imperfection? On this point, Darwin is oddly silent, so we will have to do more work on his behalf.

The causal modeling framework detailed in Section 2 provides the tools for such an argument. Suppose Darwin has effectively shown that variation is probabilistically independent of selection. The CFC states that if variables A and B are causally connected — either via a direct causal link or as effects of a common cause — then A and B will be probabilistically dependent. Since variation and selection are unconditionally probabilistically independent, Faithfulness entails that there is no direct causal link between variation and selection *and they are not effects of a common cause.*

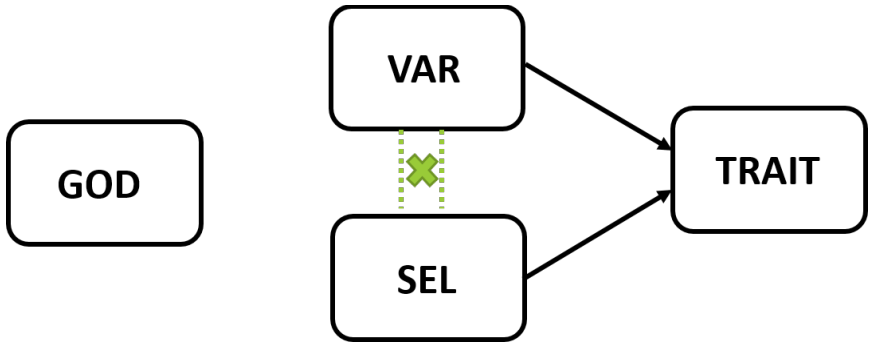

Figure 12. A causal model of theistic creationism. If variation and selection are independent, then they have no common cause.

The argument from independence can now be fleshed out as follows:

1. Causal Faithfulness Condition: if two variables are unconditionally independent, then there is no causal relationship between them, nor are they joint effects of a common cause.

2. Variation and selection are unconditionally independent.

3. From (1) and (2), there is no causal relationship between variation and selection, nor are they joint effects of a common cause.

4. From (3), there is no unified cause of evolutionary processes.

5. If an outcome of evolution is designed, then it must trace back to a unified cause, such as an intention, goal, or act of a designer.[29]

29. It is worth pointing out that Faithfulness does not strictly rule out the

C: The outcomes of evolution are not designed.

This argument evades the major problems that beset the argument from imperfection. First, it does not depend on any judgments about trait functions. Second, it evades the Preference Problem because it rules out a designer from a domain-general causal principle; Faithfulness rules out any unified upstream cause of evolution, regardless of its capacities or desires.

With this argument, Darwin seems to have resolved a major confusion in his thinking about chance. Darwin glimpsed that there were processes that were chancy, caused, and lawlike, and yet not designed. Consider a "chance" meeting with a friend at the grocery store. It is perfectly explicable how each of you ended up at the store, but there was no unifying causal process that caused each of you to be there at the same time (Sober 2012). To the list in Section 5.2, we can add a conception of chance as causal independence, as "chance or accident resides for Darwin in the interaction of those two sets of causal chains, understanding accident as the effect of the concurrence of two causal sequences" (Noguera-Solano 2013, 867).

8. Objections to Premise 2 of the argument from independence

The argument from independence claims that (a) variation and selection are probabilistically independent and that (b) this fact is incompatible with design. In this section, I will consider an objection to (a), and in the next, I will consider objections to (b).

If the Faithfulness assumption is true of all possible causal systems, then God could not create through evolutionary means. However, it is well known that Faithfulness is often violated, especially in the biological domain (Andersen 2013; Cartwright 1999). If it is possible for actual causal structures to violate Faithfulness, then can we rule out that God's design is also unfaithful?

existence of God as a cause of evolutionary processes. If God's intention for selection were a distinct causal variable from God's intention for variation, then "God" would be two distinct causes and the model would not violate Faithfulness. This will be discussed further in the next section.

In a canonical example, taking birth control and getting blood clots are probabilistically independent of one another; Pr(Clot|Pill) = Pr(Clot). Faithfulness would thus rule out any model on which the pill causes clots. However, this rules out the correct causal model; the pill *does* cause blood clots, but it also prevents pregnancy, which causes blood clots. These two causal pathways cancel each other out, yielding the overall independence of the pill and clots:

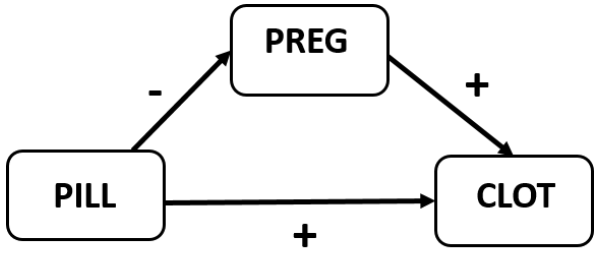

Figure 13. A causal model that violates the Causal Faithfulness Condition (CFC).

In order for two pathways to cancel each other out, the causal variables and links must take on very specific and coordinated parameter values (e.g., if we increased the efficacy of birth control pills in reducing pregnancy, we would no longer expect the paths to cancel). As Weinberger (2018) argues, many of these cases involve an additional "coordinating" cause, not depicted in the original causal graph, which causes the parameters to take these precise values and is hence responsible for maintaining the balance between the two paths. Once we include that cause, the structure does not violate Faithfulness. In this case, we suppose that God is a common cause of both variation and selection and ensures that the two are random with respect to each other. He *could* do this, but *would* he? Would it count as design?

A first objection is that creation via independent variation and selection pathways would be massively inefficient. A God that creates via random mutation has to wait for a beneficial mutation to arise, which would take much longer and include much more suffering and death than if God had ensured, right away, that the right variants would arise or had simply created the desired trait by fiat. Certainly, Darwin (1887) was inclined toward this argument from evil. However, this response does not evade the Preference Problem, for it depends on an assumption about God's capacities (he is omnipotent so could take more efficient means to his ends) and desires (he is omnibenevolent so would desire to minimize suffering). A theist who rejects either of these assumptions could maintain the consistency of evolution with God's providential design.

To evade the Preference Problem, we need a reason why *no* designer would proceed in this way. A plausible condition on agency is that an agent does not take random means to their ends; means are selected because they (are believed to) promote desired outcomes. Indeed, we often choose random processes like coin flips as intervening steps precisely when we want to blunt the effects of our intentions, for these steps eliminate agential bias toward favored outcomes. The objection, then, is that whatever their capacities and desires are, a designer, *qua* designer, will take non-random means to their goals.

There might be counterexamples to this principle of agency. The hypothesis here is that God randomly generates variations and then selects among them to produce favored traits. In some real-world cases, this process is perhaps more efficient than hand selecting desired variants. For example, a stumped engineer might try out random solutions to a design challenge and then evaluate which works best. Commonly used Monte Carlo learning processes start by randomly generating starting points, testing which of them works best, and then iterating the process by randomly generating new starting points clustered around the previous best outcome. However, I suspect that these processes of randomness plus selection are only useful because we do not know the correct solution to a design challenge. This is not a circumstance that an omniscient designer would find herself in, though a theistic creationism that posits an epistemically limited designer may be compatible with this kind of design.

9. Objections to Premise 1of the argument from independence

As we saw in Section 6, Darwin's chief argument for the independence of variation and selection is that manipulations of the selective environment can yield trait changes in any direction. The experiments that are cited today as establishing independence have a similar logic; identical populations are simultaneously subjected to different selective environments, and there does not appear to be any observed difference in the probabilities of various mutations across different selective environments.

Do these results show that there is *complete independence* of mutation and selection? Darwin showed that there is sufficient variation to allow breeders to move populations in various directions, but he could not have ruled out that it was easier to move in certain directions or that these efforts did not get some slight boost from biased mutations.[30] Furthermore, it would seem erroneous for Darwin to infer that the efficacy of artificial selection for a particular trait in a population should be proportional to the proportion of variations that arise for that trait. For example, in order to produce a population of cats with blue eyes, it might only be necessary for the blue-eyed variant to arise once (and still be vastly less probable than brown-eyed variants).

Darwin buttresses his argument (somewhat) with two claims. First, he argues that not only can a particular breeder push their stock in any trait direction; breeders working with isolated stocks can all select in any direction they choose. Furthermore, for Darwin, directional selection requires not just occasional variants but a continual supply of them. Just as in the "slow and gradual improvement of the racehorse, greyhound, and gamecock," "species have generally originated by the natural selection of extremely slight differences" (1868, 410). Thus,

30. I am grateful to a reviewer for pressing this point.

widespread, gradual improvement seems to indicate significant standing variation of all kinds, rather than occasional guided mutations.

Nevertheless, Darwin's evidence for genuine statistical independence of variation and selection does seem rather weak. However, though Darwin didn't himself have the requisite evidence to support his argument, perhaps he has been fully vindicated by more recent experiments performed with the benefit of advanced statistics, experimental controls, and knowledge of genetics (Lenski and Mittler 1993; Luria and Delbrück 1943). However, here too there is room to deny genuine independence. When observed mutation frequencies are similar across selective environments, scientists infer that the true probabilities are identical and any small differences in frequencies are due to sampling error mutations. Because there is logical space between "observed frequencies of variations are similar across selective environments" and "the probabilities of variations are independent of selection," the theistic evolutionist can argue that variation and selection are not *truly* probabilistically independent (so Premise 1 is false).

Alternatively, she can argue that probabilistic independence at the aggregate level does not suffice to establish causal independence of individual events (so Premise 2 is false). As Sober (2011) argues, though variation looks random at the *aggregate* level, this doesn't rule out that *individual* mutation events were designed:

> 1. The laws of evolution contain macro-level statistical probabilities.
>
> 2. Macro-level statistical probabilities do not rule out the possibility of hidden variables.
>
> C: Hence, the laws of evolution do not rule out the possibility of hidden variables.

In particular, "the hypothesis that the different mutations have the same probabilities in different environments does not rule out the possibility that there are hidden variables … notice that these models say nothing about whether there have ever been mutations that God made sure would happen" (Sober 2011, 138).

By analogy, consider two fair coins whose behaviors are probabilistically independent; that is, the Pr(coin 1 heads | coin 2 heads) = Pr(coin 1 heads | coin 2 tails). We flip both coins and observe the following outcomes:

> Coin 1: H T H **H** H T H T T H H T T…
>
> Coin 2: T T H **H** T T H T H H T T H…

Suppose that getting two heads on the fourth flip is extremely fortuitous. God could have determined the outcomes of those flips without violating the fairness of each coin or their statistical independence from each other. If that is so, how could we ever rule out that an individual coin flip was so designed?

Similarly, Anscombe (1971) argues that macro-level randomness is consistent with design at the micro-level via the following thought experiment:

> Suppose that we have a large glass box full of millions of extremely minute coloured particles, and the box is constantly shaken. Study of the box and particles leads to statistical laws, including laws for the random generation of small unit patches of uniform colour. Now the box is remarkable for also presenting the following phenomenon: the word "Coca-Cola" formed like a mosaic, can always be read when one looks at one of the sides. It is not always the same shape in the formation of its letters, not always the same size or in the same position, it varies in its colours; but there it always is. It is not at all clear that those statistical laws concerning the random motion of the particles and their formation of small unit patches of colour would have to be supposed violated by the operation of a cause for this phenomenon which did not derive it from the statistical laws. (15)

There are many different micro-level states that are consistent with macro-level statistical laws (even macro-level statistical independencies), which suggests that God could have some leeway in determining which of these micro-states obtained.

The upshot is that God could ensure that certain important mutations occur in one of two ways: by directly influencing a particular mutation event[31] or by setting up independent causal processes but ensuring at the start that particular events would coincide at the right time and place. Since either of these could occur without violating the statistical independence of variation and selection, either statistical independence does not suffice to show probabilistic independence *or* probabilistic dependence does not rule out the possibility of design.

In *Variation,* Darwin suggests that either God creates variation entirely via secondary laws or that "each particular variation was from the beginning of time preordained" (1868, 428).[32] If the latter is true, then variation is sufficient to produce adaptations and natural selection is superfluous (both explanatorily and in nature). If the former is true, then the argument from independence obtains. How should Darwin have responded to the hypothesis that only the occasional variation was preordained?

Darwin might repeat his argument above that *if* God can create beneficial variations directly, then there is no reason for him to create via natural selection, which would be at the same time totally superfluous and quite brutal. If God can create variations directly, then why would he create an inherent tendency for "that plasticity of organization, which leads to many injurious deviations of structure" (*ibid.*)?

More generally, if the Designer's activities have to maintain overall statistical independence of variation and selection, this places extremely strong constraints on his creative activity. As Anscombe puts it, "certainly if we have a statistical law, but undetermined individual events, and then enough of these are supposed to be pushed by will in one direction to falsify the statistical law, we have again a supposition that puts will into conflict with natural laws" (1971, 14). It seems that the Designer must therefore compensate for the beneficial mutations with non-beneficial ones to restore balance. While not logically impossible, this view seems *ad hoc* and runs afoul of the problem of evil.[33]

Aside from these theological challenges, does Darwin have any good *epistemic* reasons for ruling out occasional divine interpositions? While Darwin would not, and ought not, conclude that his theory has deductively disproved the possibility of such events, there are several inductive and methodological reasons to reject them. First, neither of Darwin's favored scientific methodologies would support the postulation of such interventions (Ruse 1979, 179). They are not a *vera causa*, or something already known to exist that could then be used to explain biological outcomes of interest. Neither would a Whewellian consilience of inductions promote the postulation of such interventions, as they do not seem to explain anything further or connect previously disconnected observations. Occasional divine interventions seem both *ad hoc* and incapable of being subsumed under any general laws.

Second, Darwin frequently argues that reasoning in biology and natural history ought to obey the same general principles as our reasoning in other areas of science, especially physics (1859, 453). If we adhere to Faithfulness in our general causal reasoning, then it would be *ad hoc* to deny it here. However, the fact that aggregate-level statistical independence is compatible with lower-level causal dependence would seem to be a reason to doubt Faithfulness more generally, so an

31. Gray suggests that one could supplement theistic evolution with "theory of insulated interpositions, or occasional direct action, engrafted upon it — the view that events and operations in general go on in virtue simply of forces communicated at the first, but that now and then, and only now and then, the Deity puts his hand directly to the work" (1876, 158). A similar view was adopted by Herschel after the *Origin* (Ruse 1979, 249).

32. Darwin doubts that the distinction is genuine, as "an omnipotent and omniscient Creator ordains everything and foresees everything" (1868, 428).

33. One major theological advantage of the view is that occasional divine interpositions could render key evolutionary outcomes non-contingent. If evolutionary trajectories — such as the one leading to humans — depend on purely random mutations, then our existence was not ensured or even probable (Gould 1989).

independent justification of Faithfulness is called for. While such justifications have been given (Lange 1995; Weinberger 2018), they tend to rely on explanatory benefits of faithful hypotheses, not a proof that the world must be faithful.

10. Conclusion

As we have seen, it is possible to construct special creationist views that can accommodate the data of imperfect and functionless traits. It is also possible to construct theistic evolutionist views that can accommodate the independence of variation and selection. So, in the final reckoning, is the argument from independence any more successful than the argument from imperfection?

Darwin did not need to provide — and, indeed, did not take himself to have provided — a deductive argument that logically precluded the possibility of design. He needed only to make design improbable or inconsistent with theologically desirable theories of the Designer's nature. On this count, I think that the argument from independence is indeed more successful than the argument from imperfection.

First, the existence of imperfections places some constraints on what the Designer must be like, for the special creationist must attribute idiosyncratic intentions to explain certain functionless traits. However, since special creationism posits that each act of creation is distinct, a single problematic causal link need not impugn the rest of the theory. Yet the independence of variation and selection is a much more systematic and global problem. It constrains God's activities for all traits and over various timescales and selective environments.

Second, and related, the theistic evolutionist must explain not just why God chose to design oddly in a particular circumstance but also why God set up the entire design apparatus as it is. God must have deliberately chosen to take largely random means to his ends. As we saw in Section 8, this is an odd thing for any designer to do, particularly one who is all knowing, all good, and all powerful.

Lastly, when we are faced with two variables that are probabilistically independent, general standards of causal reasoning tell us that they are probably not causally related. Violations of Faithfulness are possible, but to explain them we must posit either that two pathways coincidentally (and improbably) canceled each other out *or* that a hidden, occult variable caused them to cancel out. These logical possibilities have not impugned the general scientific usage of the Faithfulness condition, so perhaps they ought not do so in the special case of life's history either.

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