

Nothing in Ethics Makes Sense Except in the Light of Evolution? Natural Goodness and Evolutionary Biology*

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Abstract

Philippa Foot (2001) and Rosalind Hursthouse (1999), along with other philosophers, have argued for a metaethical position, the *natural goodness approach*, that claims moral evaluations are, or are on a par with, teleological claims made in the biological sciences. Specifically, an organism's flourishing is characterized by how well they function as specified by the species to which they belong. In this essay, I first sketch the Neo-Aristotelian natural goodness approach. Second, I argue that critics who claim that this sort of approach is inconsistent with evolutionary biology due to its species essentialism are incorrect. Third, I consider the prospects of understanding ethical normativity as a species of biological teleology claiming that this would be incompatible with

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our considered moral judgments. Fourth, after presenting gene-culture coevolution theory, I argue that the only way of reconciling naturalism and normativity in accordance with the natural goodness approach requires amending the selected effects function account to include cultural evolution. However, this approach, though not biologically reductionistic, still generates claims incompatible with our considered moral judgments. Finally, I end with a discussion of methodology and revisionistic moral theories.

1 Introduction

One of the most challenging topics in contemporary philosophy is normativity. Specifically, the most difficult aspect of this topic is making sense of normativity in a wholly natural world. We can motivate the challenge of normativity by considering the “argument from queerness” articulated by J. L. Mackie (1990). Consider stereotypical natural properties like *mass*, *negative charge*, *carapace*, *polypeptide*, *species*, and so forth. If there are normative ethical or epistemic properties, then they would have to have an intrinsic “to-be-pursuedness” to them. However, Mackie claims that there are no such properties described by the natural or social sciences. If the only properties are natural properties (i.e. those described by the natural and social sciences) and there are no normative natural properties, then it follows that there are no normative properties. Of course, there are a variety of ways of responding to Mackie’s argument. One could deny that there are moral properties; rather, moral or epistemic judgments are expressions of commitments to various plans (Blackburn, 1984; Gibbard, 1992). Additionally, one could argue in a Humean fashion that what one should do is always a function of beliefs *and* desires. However, the latter can be made sense of in a natural world (Railton, 1986). Likewise, one could argue that there are natural properties with this “to-be-pursuedness”; specifically, these properties can be found in the biological sciences (Casebeer, 2003; Post, 2006). An understanding of such properties is thought to come from evolution by natural selection. Consider your heart. It has the function of circulating blood through your body. That is, this is what it is *supposed to do*. It came to have this function because it was this effect for which it was selected against other heritable variants. Insofar as your heart does not circulate blood it is *malfunctioning*. Thus, one strategy of reducing normativity to

natural properties is through evolutionary biology.¹

One bold approach to ethical normativity is offered by contemporary Neo-Aristotelians. They are of the view that normative claims made of non-human animals and plants are of the same form as that of ethical judgments we make with regard to our own species. However, their views sit uneasily with biological teleology as we shall see. In this essay, I take this “natural goodness approach” seriously. First, I provide a sketch of this approach highlighting how uncomfortable Neo-Aristotelians have been with reducing ethical normativity to evolutionary biology. Second, I consider a challenge that philosophers such as David Hull (1986) and Philip Kitcher (1999) have offered regarding approaches that ground normative ethical claims in human nature. After some discussion, I find their challenge wanting since it presupposes a particularly strong form of essentialism that is optional. Third, I consider the prospects of reducing ethical normativity to the work of evolution by natural selection. Though Neo-Aristotelians reject this move, it is instructive in considering how such an approach would violate our considered moral judgments. I give one such example by considering Randy Thornhill and Craig Palmer’s (Thornhill and Palmer, 2001) speculative work on the evolution of rape. Finally, I argue that the only prospect of reconciling naturalism and normativity must come from understanding teleology through a “gene-culture coevolutionary” account of selected functions. However, I argue that it has very similar conflicts with our considered moral judgments. Insofar as altruistic punishment has evolved by cultural group selection, it has the function of driving other less altruistic groups socially extinct which is extremely problematic from a moral point of view. Lastly, I urge that insofar as moral theories are revisionistic, thus rejecting considered moral judgments, they must do so in a way that is not ad hoc.

2 Natural Goodness

Neo-Aristotelian Naturalism, or what I will call the *natural goodness approach*, is an important option in metaethics and has been ably defended by G. E. M. Anscombe, P. T. Geach, Philippa Foot, Rosalind Hursthouse, Martha Nussbaum, Judith Jarvis Thomson, and Michael Thompson. On this view, a character trait

¹It is worth stressing that these different sources of normativity are not strictly speaking incompatible with one another. It is only arguments like Mackie’s argument from queerness that encourage us to make a choice.

is a virtue if, and only if, it is a trait that a human needs in order to live well or flourish. This notion of flourishing is not *sui generis* but as Hursthouse suggests, “when we talk about ethically good human beings, we have not suddenly started to use the word ‘good’ in a totally new ‘moral’ or ‘evaluative’ way” (Hursthouse, 1999, 226). As, Peter Geach writes,

Men need virtues as bees need stings. An individual bee may perish by stinging, all the same bees need stings; an individual man may perish by being brave or just, all the same men need courage and justice. (Geach, 1977, 17)

The notion of flourishing is a naturalistic one understood in same manner as functional claims offered in the biological sciences.

One way of motivating the approach is by considering the semantics of the term ‘good’. Utilitarians, and consequentialists more generally, have thought that ‘good’ is a predicative adjective. Consider the sentence, “This is a green computer.” This claim implies “This is a computer” and “This is green.” Grammatically, the adjective ‘green’ can come before the noun or after the copula. However, attributive adjectives are not like this. For example, consider the sentence, “Charlie is a small dog.” This claim does not imply “Charlie is a dog” and “Charlie is small.” The reason for this is that the property *smallness* depends on the type or kind of object of which we are making the predication. On the natural goodness approach, the property *goodness* is always *goodness in a way*. As Foot writes,

Such a colour word operates in independence of any noun to which it is attached, but whether a particular *F* is a good *F* depends radically on what we substitute for ‘*F*’. As ‘large’ must change to ‘small’ when we find that what we thought was a mouse was a rat, so ‘bad’ may change to ‘good’ when we consider a certain book of philosophy first as a book of philosophy and then as a soporific. Seen in the light of Geach’s distinction, thoughts about good actions, which are fundamental to moral philosophy, appear with thoughts about good sight, good food, good soil, or good houses. (Foot, 2001, 2 - 3)²

²Foot seems to be overstating the point. The term ‘green’ does not operate completely independently of the noun to which it is attached. For example, if I say “7 is green” I have made a category mistake since numbers are not colored.

The notion that *goodness* is always relative to a kind is contrary to utilitarianism, for example. Suppose x is good and y is good. Thus, according to utilitarianism, either x is better than y , y is better than x , or they are equal in value. This is true independent of what x and y are. Neo-Aristotelians deny *goodness* is like this.

The natural goodness approach is a cognitivist metaethical theory in that moral claims are truth-apt; i.e. they are either true or false.³ However, unlike J. L. Mackie's cognitivist error theory, some positive moral claims are true according to Neo-Aristotelians.⁴ Additionally, since the natural goodness approach is naturalistic, then moral properties are just natural properties. Whether one regards this as a reductionistic theory really depends on how we understand reductionism. If we consider psychological, biological, anthropological, sociological, etc. properties as natural, then moral properties *just are* natural properties. They reduce to them. However, reductionism in other contexts like the philosophy of mind often considers reductionism as requiring that mental states reduce to physics. The natural goodness approach is not committed to this stronger form of reductionism.

Additionally, most proponents of the natural goodness approach are supporters of virtue ethics as the correct normative theory. We can summarize this approach following Rosalyn Hursthouse. According to virtue ethics,

P1. An action is right iff it is what a virtuous agent would characteristically (i.e. acting in character) do in the circumstances.

P1a. A virtuous agent is one who has, and exercises, certain character traits, namely, the virtues.

P2. A virtue is a character trait that... (Hursthouse, 1999, 28, 29)

³For the purposes of this paper, I am ignoring deflationary approaches to truth (Armour-Garb and Beall, 2005). There is a worry that deflationary approaches trivialize the differences between cognitivist and non-cognitivist theories (Dreier, 1996, 2004). Consider the Equivalence Schema $\langle p \rangle$ is true if, and only if, p where $\langle p \rangle$ is a name forming operator on p . Thus, the claim $\langle \text{Murder is wrong} \rangle$ is true if, and only if, murder is wrong. But this seems to imply that moral claims are trivially true. For example, suppose a simple-minded emotivism was correct and "Murder is wrong" is equivalent to "Boo murder!"; this would still seem to suggest controversially such moral imperatives were truth-apt.

⁴On Mackie's error theory, a positive moral claim like "Murder is morally wrong" is false because the term 'morally wrong' is non-referring since there is no such property *moral wrongness*.

Presumably, (P2) can be fleshed out by providing a list of the virtues and criteria for what makes those traits virtues. For example, virtues are those traits that benefit the possessor or contribute to eudaimonia (i.e. human flourishing). The important point here is that one can subscribe to the natural goodness approach without subscribing to virtue ethics of the above sort. Consider character consequentialism which holds we should choose or inculcate those character traits which produce the greatest expected well-being (Driver, 2001). One could consistently claim that our well-being is given by the natural goodness approach. The two theories would not be extensionally equivalent.⁵

Following Elizabeth Anscombe, a fundamental notion for the natural goodness approach is what is termed an “Aristotelian necessity.” An Aristotelian necessity is something which is required for an *F* to be a good *F*. Foot writes,

We invoke the same idea when we say that it is necessary for plants to have water, for birds to build nests, for wolves to hunt in packs, and for lionesses to teach their cubs to kill. These ‘Aristotelian necessities’ depend on what the particular species of plants and animals need, on their natural habitat, and the ways of making out that are in their repertoire. These things together determine what it is for members of a particular species to be as they should be, and to do that which they should do. And for all the enormous differences between the life of humans and that of plants or animals, we can see that human defects and excellences are similarly related to what human beings are and what they do. We do not need to be able to dive like gannets, nor to see in the dark like owls; but our memory and concentration must be such as to allow us to learn language, and our sight such that we can recognize faces at a glance; while, like lionesses, human parents are defective if they do not teach their young the skills that they need to survive. (Foot, 2001, 15)

As examples, a Neo-Aristotelian would claim a rhododendron which does not flower or an oak tree with shallow roots are defective since they do not have those features conducive to their flourishing. This is also true for antisocial

⁵One way of seeing this is that virtue ethics is not a maximizing theory whereas character consequentialism is. However, one could evaluate character traits with regard to their expected consequences without thinking these traits could be maximized or even are commensurable with regard to one another. Thanks to Richard Boyd on this point.

bonobos and free-riding wolves (Sandler, 2005). If we say that a person is a good human being, we are saying they must have those properties which are required for them to be good *qua* human being. That is, if we say that Sheila is a good *Homo sapiens*, then she must have those properties which are necessary for her to be good *qua Homo sapiens*. The logical structure of moral judgments then have the same form as when we ascribe functional properties to organisms. If a sequoia is a good *qua Sequoia sempervirens*, then it has those features required as a member of that species to be a good instance of it.

Clearly, the characteristics which make for a good human can be different from that of other species. As human behavioral ecologists have noted, human life history traits are relatively unique. We differ from other primates in that our children depend on us for subsistence far longer than other mammal's offspring, we wean babies earlier than most other apes do so, and the age of first reproduction is much older comparatively (though our fertility can be greater than other apes). Additionally, we have the longest average age of the terrestrial mammals though women stop giving birth in the middle of their lives. It is worth noting that what features or traits are conducive to the flourishing of a human being need not be universally applicable across different individuals of a species or different life stages of the same individual. It can be the case that what characteristics are conducive to flourishing varies with regard to sex, age, stage, and habitat.

Hursthouse argues we should evaluate living things as members of their kind. One is a good member of a kind when one contributes in ways characteristic of that kind to the ends of survival and reproduction (and possibly to the characteristic enjoyments of the kind and where rationality plays a role in *Homo sapiens*). She writes,

A good social animal (of one of the more sophisticated species) is one that is well fitted or endowed with respect to (i) its parts, (ii) its operations, (iii) its actions, and (iv) its desires and emotions; whether it is thus well fitted or endowed is determined by whether these four aspects well serve (1) its individual survival, (2) the continuance of its species, (3) its characteristic freedom from pain and characteristic enjoyment, and – the good functioning of its social group – in the ways characteristic of the species. (Hursthouse, 1999, 202)

A free-riding wolf, a non-sharing bee, or a nurturing polar bear are defective. Ethical evaluations are made with regard to our characteristic properties in-

cluding rationality. But there is nothing *essential* about rationality; it possible other features like fire-making or cooking could be species typical for us.⁶

Defenders of the natural goodness approach have denied that moral evaluative claims can be *reduced* to biological ones. Rather they are “on a par” with them. Put differently, they are of the same form as biological functional claims.

It is imperative that the word ‘function’ as used here is not confused with its use in evolutionary biology, where, as Simon Blackburn has put it in the Oxford Dictionary of Philosophy, ‘the function of a feature of an organism is frequently defined as that role it plays which has been responsible for its genetic success and evolution’ (149-50)... It is easy to confuse these technical uses of words such as ‘function’ and ‘good’ with their everyday uses, but the meanings are distinct. To say that some feature of a living thing is an adaptation is to place it in the history of a species. To say that it has a function is to say that it has a certain place in the life of the individuals that belong to that species at a certain time. (Foot, 2001, 32)

We are not then interpreting it as a historical question, as ‘proper function’ is interpreted, for instance, by Ruth Millikan in *Language, Thought, and Other Biological Categories*, chapter 1, and as ‘function’ would generally be interpreted in evolutionary biology. As David Wiggins says in Postscript 4 in *Needs, Values, Truth*, 353, ‘we really need to describe what morality has become, a question on which evolutionary theory casts no particular light’. (Foot, 2001, 40)

Hurtsthouse reaches a similar conclusion in her discussion of Bernard Williams’ (Williams, 1983) criticisms of Neo-Aristotelianism.

One thing this passage draws to our attention is that the non-ethical evaluations of living things that I have outlined are ‘Aristotelian’ rather than Darwinian. They do, as I have been at pains

⁶It is worth noting that some use the term ‘human’ to be synonymous with the concept PERSON. However, I use the term ‘human’ be synonymous with the concept HOMO SAPIEN. Hence, one might claim that the property *rationality* is essential to personhood. Fair enough. But, it does not follow that it is essential to being a member of our biological species.

to emphasize, rely on the idea that there is, in relation to each natural kind of thing, 'an appropriate (= characteristic) way for things of that kind to behave' in relation to which they are evaluated as good or defective. The evaluations do not – as they might in a post-Darwinian age – evaluate members of species of living things simply as good, or not so good, or downright defective, as replicators of their genes. (Hursthouse, 1999, 257)

As we shall see in §4, there are non-historical accounts of function. However, they cannot do the job that Foot and Hursthouse want. Additionally, their view creates a tension for the natural goodness approach. That is, they face the following dilemma. If moral evaluative claims are reducible to biological ones, then there will be problematic ethical implications of the natural goodness approach. If moral evaluative claims are not reducible to biological ones, then it is unclear how the natural goodness approach is naturalistic. The only good theory we have of normative natural functions is the selected effects account (Millikan, 1984; Neander, 1991; Godfrey-Smith, 1994). In this essay, I argue that this dilemma renders the natural goodness approach very problematic.

3 Natural Goodness Meets Evolutionary Biology

One popular view of the sciences is that they investigate *natural kinds*.⁷ For simplicity, we can start with the idea that a natural kind is a group of objects such that there are essential properties which they share and which explains the other properties they possess. As examples, the kind *gold* is characterized by all of those things which have the atomic number 79 or the kind *carnivore* is characterized by all those things which have the property of being an exclusive flesh-eater. One can defend a *global* or *local* essentialism. *Global essentialism* is the view that for any science, the objects it investigates include natural kinds defined by essential properties. *Local essentialism* suggests that some sciences investigate natural kinds but others may not.⁸ Additionally, we can

⁷Here I follow the discussion found in (Sober, 1980).

⁸To be clear, a science may investigate natural kinds and concrete particulars. For example, astronomy investigates the kind *black hole* but also specific black holes like V4641 Sgr located near the Sagittarius arm of the Milky Way. Some sciences however may not investigate natural kinds at all. Some have alleged that evolutionary biology is such a science.

distinguish between *kind* and *token essentialism* (LaPorte, 1997).⁹ The former claims that kinds have essences and the latter claims particulars have essences. For example, necessarily x is nitrogen if, and only if, x has atomic number 14. However, this does not mean that for some bit of nitrogen it cannot “transmute” into some other element.

To start, if species are natural kinds, then they must have essential properties. If species have essential properties, then necessarily there is at least one property which all and only the members of that species possess where that property must explain why the members are the way they are. According to Sober (1980), essentialism about species was largely supported by a commitment to Aristotle’s natural state model. For any natural kind, there is a natural state which instances of that kind tend to and they depart from that natural state when interfering forces occur (e.g. in Newtonian physics an object remains in motion unless affected by a force). Thus, “monsters” in biology are the product of natural tendencies and interfering forces. However, are there natural states in biology?

In the 19th century, we have the rise of statistics, which codifies the notion of “normality” with the concepts of a mean and variance or standard deviation. Eventually, errors are simply understood as variation. The crucial point is that variation is not explained away but becomes explanatory itself. For a range of genotypes and environments, we have a set of phenotypic values; however, there are no normal genotypes and environments. Hence, there are not normal phenotypes. This is what is called a *norm of reaction*. Population thinking does not view traits as normal but rather studies the statistical properties of populations. Period. One might object that we find zero-force laws in evolutionary theory. For example, consider the Hardy-Weinberg equation which states that when there is no selection, mutation, migration, and populations are effectively infinite in size, gene frequencies p and q of alleles A and a at a locus will be $p^2 + 2pq + q^2$. One might think that forces such as natural selection, mutation, migration, or random genetic drift are interferences. However, there is no reason to suppose that the absence of such processes is the natural state of a population. Likewise, there is no reason to think of these forces as interferences.

⁹Some philosophers such as Richard Boyd deny that kinds and tokens are metaphysically distinct. Some philosophers of biology such as David Hull have argued that species are individuals (i.e. concrete particulars) and not natural kinds. However, Boyd denies that the category INDIVIDUAL and NATURAL KIND are ontologically distinct. Hence, if right, he can trivially accept the species as individuals thesis.

From the rejection of the natural state model, we find arguments against species essentialism from David Hull (Hull, 1986) and Philip Kitcher (Kitcher, 1999). According to David Hull, if *Homo sapiens* is a natural kind, then there are intrinsic properties which necessarily all and only humans have. However, there are no such properties since evolutionary processes can eliminate or introduce any such intrinsic property. Therefore, *Homo sapiens* is not a natural kind. Of course, even if there is no intrinsic property essential to a species it does not follow there are no extrinsic properties essential to a species which is in fact Hull's own view. Specifically, a species position in the phylogenetic tree could not be other than it is. This is analogous to the claim of Saul Kripke that one has one's parents essentially. However, it is hard to find a non-circular argument for such a modal claim.¹⁰ As such, I will disregard it for now. Note the argument here would apply to other biological species as well.

Philip Kitcher (Kitcher, 1999) criticizes Neo-Aristotelianism on different grounds. Roughly, if *Homo sapiens* has at least one essential property it will not be a property like *rationality* since we could evolve to have very minimal cognitive powers. Likewise, non-humans could evolve much greater cognitive powers. So, even if our species has an essence, it will not be what Neo-Aristotelians celebrate.¹¹

A response to the above pair of arguments comes from Richard Boyd (Boyd, 1988b, 1991, 1999).¹² He claims that traditional Lockean empiricism assumes that kinds are conventional, defined in terms of necessary and sufficient conditions (via intrinsic properties), unrestricted with regard to time and place, described by exceptionless natural laws, and membership occurs in virtue of sharing properties. On his Cornell realist account, he contends kinds are real and known a posteriori; however, he denies that they must be defined in terms of necessary and sufficient conditions. According to Boyd, for any kind, there is a family of co-occurring properties such that their co-occurrence results in a sort of homeostasis. The homeostasis in the family occurs because

¹⁰Thomas Hurka raised the following objection to this response. If necessarily a species has the phylogenetic position it does, then it follows that necessarily scientific creationism is false. However, most of us regard scientific creationism as merely contingently false not necessarily so. However, in our post-Kripke philosophical world, we have become accustomed to the idea that certain truths known a posteriori are unexpectedly necessary.

¹¹Notoriously, Kitcher (Kitcher, 1984) has argued that species are best construed as sets and not concrete particulars or natural kinds. So, Hull's and Kitcher's respective critiques though similar are importantly different.

¹²For a similar though different response, see the following discussions in Machery 2008; Lewens 2012; Machery 2012; Ramsey 2012.

(a) either properties in the family are causally related or (b) result from some common mechanism. For a natural kind, there is a kind term k that is applied to the family, the homeostatic property cluster. There is no analytic definition of k in terms of necessary and sufficient conditions since the homeostasis is contingent and imperfect. The “essence” of a homeostatic property cluster kind is contingent and known a posteriori. Given the imperfect homeostasis, there will “extensional indeterminacy” with regard to k (i.e., there will be an x such that it will be neither true nor false whether k applies to an x). The upshot of Boyd’s position is this – we need not assume that natural kinds have modally strong essences. Rather, essences might concern the clustering of intrinsic and extrinsic properties (however, see Ereshefsky (2010) for a contrary view). If this is so, then the above arguments against species essentialism are unsound since they assume a very strong form of essentialism.

Another interesting argument against species essentialism is this (Hull, 1978, 1976).

Similarly, if all gold atoms were to cease existing, the class of gold atoms would temporarily have no members. Later when atoms arose with the appropriate atomic number, gold would come into existence again. However, once a species becomes extinct, it cannot arise again. If a species of flying reptile were to evolve which was identical in every respect to a species of extinct pterodactyl save origin, it would have to be classed as a new species. (Hull, 1976, 184)

Hull assumes that species are historical entities which are spatiotemporally continuous; they have no “temporal gaps” (Ereshefsky, 1992). That is, if a species go extinct at t , it is impossible for it appear at t' (where $t < t'$). But, Boyd could simply suggest that if a species goes extinct then it is very improbable for it to exist at t' . At the root of this disagreement is whether necessarily if all the members of species cease to exist at t , nevertheless, instances of that species can exist at t' .¹³

¹³A more effective defense of species as historical, spatiotemporal entities, is this.

Since the inception of evolutionary theory, species taxa have been considered evolutionary units, that is, groups of organisms capable of evolving. The evolution of such groups requires that the organisms of a species taxon be connected by heredity relations. Heredity relations, whether they be genetic or not, require that the generations of a taxon be historically connected, otherwise information

So far, contrary to the work of David Hull (Hull, 1986) and Philip Kitcher (Kitcher, 1999), we have not seen that there is a particularly strong argument from evolutionary biology against species essentialism. Thus, there is not, so far at least, an argument against the natural goodness approach. However, things become more complicated when we turn to biological functions.

4 Natural Goodness and Functions

Philosophers have spilt much ink attempting to make sense of functional claims. A particularly important account is (Wright, 1973, 1976). On Wright's view,

The function of x is to z means (a) x is there because it z s, and
(b) z is a consequence of x 's being there.

The usual example of his analysis is an old favorite: that the function of the human heart is to circulate blood means the heart is there because it circulates blood, and circulating blood is a consequence of human hearts being there.¹⁴ This account was rejected due to many criticisms; here is one due to Christopher Boorse (Boorse, 1976). Suppose in a scientist's lab there is a gas leak rendering the scientist unconscious; it appears that this case satisfies both (a) and (b) above. The function of the gas is to render the scientist unconscious means the gas leak is there because it renders the scientist unconscious and the scientist's unconscious state is a consequence of the gas leak. Surely, the gas leak has no function or at least not this function.

will not be transmitted. The upshot is that if species taxa, or any taxa, are to evolve, they must form historically connected entities. (Ereshefsky, 1992, 688).

But, one might object that hereditary relations require correlations between properties of parents and offspring not that they be spatiotemporally continuous. One way of achieving such correlations is through material overlap and thus spatiotemporal continuity (Griesemer, 2000) but it does not seem necessary.

¹⁴It is important to note that Wright's account is a conceptual analysis of what he takes the meaning of functional claims to be (or at least some paradigm cases). Current accounts do not necessarily claim to be offering a conceptual analysis. Thus, consider Donald Davidson's "swampman" (Davidson, 1987) – suppose a molecule-for-molecule replica of a human is created by lightning in a swamp. According to the selected effects historical account, this swampman's heart would have no function. However, if one is not giving a conceptual analysis of the concept BIOLOGICAL FUNCTION, then it is not clear what force such recondite examples have (Millikan, 1984; Neander, 1991).

A common response to Wright's etiological account is to articulate it in the context of evolution by natural selection. Put very simply,

The function of a trait T is that for which T evolved by natural selection in the recent past.

A trait evolves by natural selection if, and only if, the trait is heritable, entities with the trait have greater reproductive success relative to alternatives due to possessing it, and there is variation with respect to the trait. Thus, the human heart has the function of circulating blood if, and only if, having a human heart is heritable, having a human heart contributed to the reproductive success of those who possessed it in the recent past by circulating blood relative to the alternatives, and there was variation in the recent past with respect to humans hearts concerning the circulation of blood. A more sophisticated account of selected effect functions is due to Peter Godfrey-Smith.

The function of m is to F iff: (i) m is a member of family T , (ii) members of family T are components of biologically real systems of type S , (iii) among the properties copied between members of T is property or property cluster C , (iv) one reason members of T such as m exist now is the fact that past members of T were successful under selection, through positively contributing to the fitness of systems of type S , and (v) members of T were selected because they did F , through having C . (Godfrey-Smith, 1994, 350)

This selected effect account avoids Boorse's counterexample since T is a token of a "reproductive family"; i.e., T is a copy of other tokens of the same kind. The gas leak is not a member of a reproductive family.

On the selected effects account of functions, if a trait has the function to F , then it is *supposed to F* and if it does not, it is malfunctioning. As such, a sort of normativity *just is* biological function. This is additionally crucial to the natural goodness approach since ethical claims are supposed to be normative and teleological by their nature. Unfortunately, the sorts of traits humans have that are functional or adaptations may often be exactly the sort of trait that we deem ethically impermissible. That is, evolution by natural selection may have selected for F but nevertheless ethical considerations suggest we should not do F . I want to consider such an example to make the point.

In their *A Natural History of Rape*, Randy Thornhill and Craig Palmer offer two hypotheses for the evolution of rape by males of our species. The

first hypothesis is that rape is an adaptation and the second is that it is a by-product of other adaptations. Their argument starts from claims regarding sex differences. Since parental investment by women involves great costs through pregnancy, nursing, and infant care, they have evolved to be exceptionally choosy with regard to their mates. On the other hand, the investment by males is much less since they may impregnate a female without any resources invested in parenting. Thus, from the point of view of selection, one should maximize reproductive success by having as many (viable) offspring as possible. For males, that means have lots of sex given that sperm is cheap. For females, that means putting lots of resources into one's offspring given that eggs and the subsequent allocation of resources are very expensive. Now consider males who have difficulty in achieving sexual access to females. If there is heritable variation in fitness with regard to rape behavior on the part of those males, then all things considered, such behaviors should be selected for. As such, this behavior would be an adaptation and would have the function of increasing expected reproductive success. Of course, the by-product hypothesis would suggest that rape behavior is not itself an adaptation though it is a consequence of other adaptations. Thornhill and Palmer consider the latter hypothesis, but accept the adaptation hypothesis as better supported.

We can formulate my objection to the natural goodness approach as follows. It is possible that males of *Homo sapiens* have an adaptation to rape women when it is difficult to secure sexual relations with females. However, if rape is an adaptation, then given the selected effects account of function, this rape behavior has the function of increasing reproductive success of these "unchoosen," low status males. That is, this behavioral disposition has the function to increase expected reproductive success. Males in those circumstances would be *malfunctioning* if they didn't rape since that is what they are *supposed* to do. Clearly however, this conflicts with our considered moral judgments regarding sexual relationships between men and women. Simply put, it is morally wrong to rape women. Moral theorists are in agreement that wide reflective equilibrium requires that we find a stable equilibrium between our considered moral judgments, normative theories, metaethical views, and the sciences. My suggestion is that if evolutionary psychologists are correct, then the Neo-Aristotelian who views ethical normativity as a species of biological normativity would have to accept rape behavior as morally acceptable.

Now, as a matter of fact, I think evolutionary psychologists are wrong in their speculations (see Lloyd 2001; Kitcher and Vickers 2003; Coyne 2000 for critical discussions). First, Thornhill and Palmer are committed to a hyper-

adaptationism, the claim that most traits are adaptations, which is implausible. Second, they characterize rape as a specifically sexual act that occurs with fertile female partners and that is sometimes true but certainly does not make sense of the rape of children, same-sex individuals, and those past reproductive age. Third, they provide next to no evidence that there is heritable variation in fitness with regard to this trait, which is what is needed to argue that it evolved by natural selection. Fourth, in the case of rape, the success rate of insemination is extremely low (approximately 2%, see Lloyd (2001)) which suggests that it is a very ineffective strategy. All of this being said, I do not think this removes the objection I have raised against the natural goodness approach. The fact that it is possible that such behavior would be functional and hence would be morally permissible should be worrisome enough.

One might respond to my objection in one of several ways. First, one might argue that in a world in which this was selected for and hence had this biological function, rape would not be regarded as morally impermissible since things would be so very different than they are.¹⁵ Unfortunately, this response does not work; evolutionary psychologists suggest as a matter of fact that this behavior is an adaptation in the actual world. We are not talking about some far flung possible world where our considered moral judgments have no force. Contrary to the above skepticism, evolutionary psychologists *could be right* and that is worrisome for a biologically grounded natural goodness approach.

A second response would be to note that Neo-Aristotelians think that character traits must be evaluated with respect to how they serve individual survival, species' continuance, freedom from pain and enjoyment, and the functioning of the social group. One might argue that a virtuous agent acting in character would not rape because of the resulting anguish suffered by the woman herself. However, this is but one of the goals mentioned and one might insist that this sort of individual is "fitted" or "endowed" quite well to the other three aspects of human flourishing. Hence, all things considered, rape behavior is what a virtuous agent acting in character would rape if they were a "low status" male.

Another response would be to reject the selected effects account of functions. In fact, this is precisely what Foot does as we saw earlier. One could employ Robert Cummins' (Cummins, 1975) systemic capacity account of func-

¹⁵Here I am thinking of R. M. Hare's (Hare, 1979) response to the objection that utilitarianism would condone slavery. His response is twofold. First, if slavery were really harmful, then utilitarianism would not condone it. Second, if it were not really harmful, then it might condone it but so what?

tions. Suppose that x is some part of a system S , has a disposition F , and S itself has some disposition C . Roughly then, the systemic capacity function of x in a system S is to F if, and only if, x is capable of F -ing and x 's capacity to F in part accounts for S 's capacity to C . The notion of flourishing needed on the natural goodness approach presupposes a notion of proper function. That is, if some x has a function F , then x *ought to* F ; there would thereby be norms of performance. One can plausibly argue that the selected effects account provides us with norms of performance since x has the function F in virtue of past x s F -ing even when x as a matter of fact cannot F . For example, a defective heart ought to circulate blood because past hearts were selected to circulate blood. However, the systemic capacity account ascribes functions even when no previous x F -ed. That is, we cannot ground norms of performance in terms of past x s F -ing. Hence, on the systemic capacity account, there are no proper functions; i.e. no natural norms. But if there are no natural norms on this view, then this account cannot supply the natural goodness approach with what it needs.

Finally, and most obviously, one might claim that ethical normativity is not a species of biological normativity. Though biological functions are one component of human flourishing, they do not exhaust it. The form of evaluative judgments in morality is the same as biological ones but that does not imply that they are biological *per se*.¹⁶ It is this last strategy that I want to pursue in the next section.

5 Natural Goodness and Gene-Culture Coevolution

Behaviorally modern humans (those with blades, beads, burials, bone tool-making, and beauty) reached the Arctic circle approximately 30,000 years ago. Suppose you are stranded on the coast of King William Island (68.935N, 98.89W) in November.¹⁷ Given that the monthly average temperature is between -25°C and -35°C , how do you stay warm? The Central Inuit used

¹⁶For two responses to worries regarding biological teleology and the natural goodness approach, see (Gowans, 2008; Lott, 2012). However, both responses in defending the natural goodness approach against similar worries as those raised in this section, push this approach in the direction of non-naturalism. As such, they are not adequate defenses of a *natural* goodness approach.

¹⁷The details of the following story come from (Henrich and McElreath, 2003).

Caribou skins that were stretched and scraped into shape and had wolverine collars. How do you build shelter? The Central Inuit built vaulted structures 3 meters high made of snow blocks cut with serrated bone knives with low doors and skins draped along the outside achieving a temperature of 10°C –20°C. How you make fire? You cannot use wood so you make stone lamps with wicks made of moss which burns seal fat fuel. How do you get food? You cover the conical chambers with snow and wait for hours for seals to move the down trigger at which point you plunge your handmade antler harpoon with a detachable head with sinew cord.

Could you make it? No. During 1845–1846, Sir John Franklin set out with two ships to explore the north coast of North America; he was an experienced Arctic traveler with an extensive library, a very select crew, and a three year supply of food. They spent the winter of 1846 trapped at King William Island stuck in the ice and after they ran out of food they left on foot and everyone died from starvation and/or scurvy. The Polar Inuit of northwest Greenland were hit by an epidemic which killed older, knowledgeable members of the group resulting in the loss of kayaks, bows and arrows, and efficient snow houses. They could not hunt caribou, and could only hunt seals and char part-time. As a result their population dwindled until they encountered an immigrating group of Polar Inuit from Baffin Island.

The crucial insight of these stories is that we do not only inherit genes but we also inherit culture. Moreover, cultural forms which are inherited can be selected for just as genes and phenotypic traits are. As dual inheritance theorists Robert Boyd and Peter Richerson write,

Culture is information capable of affecting individual's behavior that they acquire from other members of their species through teaching, imitation, and other forms of social transmission. (Boyd et al., 2003, 5).

Put very simply, dual inheritance theory, otherwise known as gene-culture co-evolution theory, argues that sometimes behavioral changes occur too quickly to be explained by genes and behavioral traditions vary even in environmentally homogeneous environments. Genes and environment undoubtedly account for some variation in human behavior but the socially transmitted component of culture cannot be ignored (Boyd, 1988a).

Social transmission can occur in several different ways (for a nice discussion of the basic concepts of gene-culture coevolutionary theory, see (Laland

and Brown, 2011, chap.7)). First, it can occur *vertically* from parents to offspring. Second, it can occur *obliquely* from parental to offspring generation; e.g. from teachers or religious elders. Third, it can occur *horizontally* from within-generation peers, e.g. as learning from friends or siblings. Selection for cultural traits is a form of *bias*. That is, the expected reproductive success of cultural variants differ. There are several forms of such bias. According to *biased cultural transmission*, given a choice between two alternative behaviors, individuals may be more likely to adopt one rather than the other. *Direct bias* occurs when individuals choose which of two alternative behaviors to adopt. *Frequency-dependent bias* occurs when the commonness or rarity of a behavior affects the probability of information transmission (which can generate conformity). *Indirect bias* occurs when cues are used to determine which individuals to observe in order to acquire information about trait.

The most common empirical example of gene-culture coevolution given is the lactose intolerance in humans. Adult humans vary considerably in their ability to digest milk because of variation in the enzyme lactase which breaks down energy-rich sugar lactose in dairy products. Absorbers reach 90% in dairy farming regions but typically less than 20% in non-dairy farming regions. Why? Because a culture of dairy farming created a selective regime for the allele for absorption. Feldman and Cavalli-Sforza (Feldman and Cavalli-Sforza, 1986) devised a model combining single-locus genetics for lactose absorption and two culturally influenced behavior traits (milk users, non-users) and showed $\Pr(\text{child milk usage} \mid \text{parent milk usage})$ is high, then there is strong selection for the allele for lactose tolerance to reach high frequencies within 300 generations. If $\Pr(\text{child milk usage} \mid \text{parent milk usage})$ is low, then unrealistically strong selection is required for the allele for lactose tolerance to reach high frequencies in 300 generations. Hence, the only way to explain the prevalence of certain biological traits is through cultural selection and inheritance.

One of the puzzling findings in the social sciences is what is called “altruistic punishment.” An example of this is the *ultimatum game*. In this game, two players interact to decide how to divide a sum of money. The first player proposes that they receive a fraction x and then the second player receives $(1 - x)$. However, the second player can either accept or reject the offer but if they reject the offer, no one receives any money. Experimentally, psychologists have shown that when the second player perceives the proportions x and $(1 - x)$ to be unfair, the second player will routinely punish the first player by ensuring they receive nothing. However, many think this is irrational since so long as

$(1 - x) > 0$, then it is in the second player's self-interest to accept the proposal given it is in one's self-interest to receive some sum of money rather than none. Traditional evolutionary explanations for such altruistic behavior such as kin selection and reciprocal altruism seem incapable of explaining such one-shot games and their results. Gene-culture coevolution models have been offered to explain altruistic punishment and its prevalence.

Samuel Bowles, Robert Boyd, Herbert Gintis, and Peter Richerson (Boyd et al., 2003) have offered one such cultural group selection model. Let me sketch their results. Suppose we have a large population with groups of size n . Suppose there are three behavioral types *contributors*, *defectors*, and *punishers*. The contributor, of which there is a fraction x , cooperates receiving a benefit b at a cost c and so their expected payoff is $bx - c$. The defector does not cooperate and hence receives the benefit but suffers no cost. Their expected payoff is bx . Since $c > 0$, then defectors should replace contributors. However, suppose punishers cooperate and punish the defectors reducing their payoff by p/n at a cost to themselves of k/n . Letting the frequency of punishers be y , the expected payoffs to contributors is $b(x + y) - c$, to defectors is $b(x + y) - py$, and to punishers is $b(x + y) - c - k(1 - x - y)$. When $py > c$, then contributors will replace defectors. However, punishers have a lower expected payoff than contributors (though as the frequency of defectors $(1 - x - y)$ decreases, then selection against punishers becomes ever weakened). So, how can altruistic punishment evolve culturally if the punisher is less fit than contributor?

Bowles, Boyd, Gintis, and Richardson modeled cultural group selection of altruistic punishment as follows. Suppose we have a N groups which maintain a constant size n due to density-dependent intragroup competition. The individuals of these groups interact in two stages. In the first stage, the contributors and punishers cooperate with a probability of $(1 - e)$ and defect with a probability e . Defectors always defect. Cooperation reduces the expected payoff of contributors and punishers by c but also increases a group's ability to compete with other groups. In the second stage, the punishers punish those who defected in the first round. After this second stage, individuals randomly pair with a probability of $(1 - m)$ with someone of their own group and m with someone of a different group. If individual i interacts with j , i imitates j 's behavior with a probability of $W_j / (W_j + W_i)$ in which W_x is the payoff to individual x in the game. This ensures that higher payoff behaviors spread within and across groups.¹⁸ Lastly, cultural group selection occurs through in-

¹⁸Also this provides heritability to these behaviors. Genes are not required for heritability

tergroup conflict in which a group drives the other to social extinction. The probability that group i defeats group j is $1/2[1 + (d_j - d_i)]$ in which d_q is the proportion of defectors in group q . Thus, as cooperation and punishment increase, defectors decrease increasing the probability that altruistic groups outcompete selfish groups.

Bowles, Boyd, Gentis, and Richardson ran computer simulations which show how the evolution of cooperation is strongly affected by the presence of altruistic punishment. There are 128 groups one with only altruistic punishers and the other 127 were only composed only of defectors. The simulations were run for 2,000 time periods. The parameter values were chosen to model cultural evolution in small scale societies or tribes based on background knowledge.¹⁹



Figure 1: The evolution of cooperation is strongly affected by the presence of punishment (Boyd et al., 2003, 3532)

between individuals since any mechanism which creates correlations between traits of “parents” and “offspring” will do the trick. Culture can do this as can genes.

¹⁹For example, they assume that the cost to the punisher is four times as costly to them rather than the punished (i.e. $p = 0.8$). Likewise, they assume that migration rates mirror that found in small societies ($m = 0.01$). They also assume that the mean group extinction rate is roughly that found in such societies (i.e. 0.0075)(Boyd et al., 2003, 3532).

In figure (a), we have the long-run average frequency of cooperation as a function of group size if there is no punishment ($p = k = 0$) for three different conflict rates, 0.075, 0.015, and 0.003. It turns out that group selection is ineffective when groups are small. However, in figure (b), when punishment ($p = 0.8, k = 0.2$) is incorporated, cultural group selection can keep cooperation prevalent in larger groups.

As an empirical example of cultural group selection (though not necessarily through altruistic punishment), consider the Nuer and Dinka who lived in the marshes of southern Sudan (see Kelly 1985, Richerson and Boyd 2008, 23-25). Both Nuer and Dinka used the same habitat with the same technologies; however, they differ in important ways. First, during the dry season, the Nuer maintained larger herds of cattle than the Dinka and never slaughtered them for food as did the Dinka. Rather, they consumed almost only grains and milk. Second, the Nuer tribes were structured patrilineally and the Dinka tribes were arranged around those who lived together in encampment. Third, the two differed over their bride-price customs. The Nuer required a minimum of 22 cows and would not take credit and the Dinka had no minimum and did take credit. The upshot of these practices is that the Nuer outnumbered the Dinka in raids often 2:1. Between 1820 – 1860, the Nuer expanded their territory conquering the Dinka by either killing them or assimilating the Dinka into Nuer tribes. Cultural evolution by cultural group selection requires variation amongst groups in their cultural feature, those features contribute to the persistence or proliferation of groups, and those cultural features are passed on generation to generation. One can argue that each of these conditions was satisfied in the intergroup conflict between the Nuer and Dinka.

Gene-culture coevolutionary theory thus provides an important “how possibly” explanation for the cultural evolution of an otherwise puzzling phenomenon: altruistic punishment. Philosophically, there are two important implications of this work for the natural goodness approach. First, cultural evolution by cultural group selection occurs when there is heritable variation in cultural group fitness. Thus, when some cultural group trait evolves in this way it comes to have a “cultural function.” The selected effects account of functions thus can be applied to cultural traits; we can merely revise Godfrey-Smith’s selected effects account to include “real cultural systems”, cultural inheritance, and transmission biases. Moreover, we can talk sensibly about what certain cultural traits, behaviors, or norms are *for*. These traits have evolved for certain effects which explain their presence and insofar as a group does not exhibit such traits we can say that they are malfunctioning – they are not

doing what they are supposed to. Second, we have the very same problem that we found in the conflict between our considered moral judgments and the implications of evolutionary biology. The exception here is that we have removed any overtones of reductionism to biology. Consider the cultural evolution of altruistic punishment. If Bowles, Boyd, Gentis, and Richardson are correct, then it evolved to facilitate the driving of less cooperative groups to extinction. That is what it is for and insofar as it does not do this the group is malfunctioning. Altruistic punishment evolved to encourage the “good functioning of its social group” precisely by eliminating other social groups or tribes. Insofar as altruistic punishment, tribal instincts, and imitative bias were culturally selected for intergroup conflict, the Nuer tribes *should have* driven the Dinka socially extinct. Moreover, if they had opted not to, then then those tribes would be malfunctioning. They would be as dysfunctional as a free-riding wolf, a non-sharing bee, or a nurturing polar bear. But surely this is not a trait that we believe should be promoted. Xenophobia leading to violence or cultural extinction is not a praiseworthy trait of a group.

Thus, we have the following dilemma. If there are natural norms that apply to our species, then those norms derive from selected effects functions. However, selected effects function derive from either evolution by natural selection or cultural evolution by cultural selection. These selection processes may shape traits that have functions which should be resisted not promoted. For the natural goodness approach to make sense, it must endorse these traits contrary to what our considered ethical judgments suggest. As such, the natural goodness approach either leads to moral problematic judgments or cannot make good on the notion of teleology operating in the theory.

6 Methodological Reflections and Revisionism

By way of summary, we have seen one solution to the problem of normativity in a wholly natural world is to understand norms as natural.²⁰ They are selected effect functions due to either evolutionary biological or cultural evolution and selection. However, what these selected effect functions are for is contrary to our considered ethical judgments. Hence, we could accept our considered moral judgments and reject the claim that selected effect functions ground ethical normativity. Or, one can always reject the considered moral

²⁰I am particularly indebted to William Rottschaefer and Nicholas D. Smith for discussion of the points in this section.

judgments of the day in favor of a particular metaethical or scientific view. Let's say that a moral theory (metaethical or normative) is *revisionist* insofar as it rejects considered moral judgments. A theory then can be more or less revisionistic and it might reject more important considered judgments than others (if we weight some judgments greater than others). One might resist the claim that rape behavior or aggressive intergroup conflict are morally bad. For example, one might argue that in very exceptional circumstances (i.e. after some apocalypse), our considered moral judgments would be very different regarding forcible sex of a woman. Likewise, one might argue that altruistic punishment should lead to the social extinction of other groups (e.g. consider a group that engages in female genital mutilation). Now, I have registered my dissatisfaction with both of these responses. First, evolutionary psychologists claim that rape is *in the actual world* an adaptation. Hence, supposing our considered moral judgments *would be* different in an apocalypse is irrelevant to the present case. Second, our considered moral judgments regarding social extinction and female genital mutilation surely would be that this social norm should be driven extinct, but the cultural group selection model applies to *any* norms which involve altruistic punishment (Boyd and Richerson, 1992). For example, Boyd and Richerson write,

Moralistic punishment is the strategy of punishing others who disobey a moral rule and also sanctioning those who do not punish others for breaking the rule. In principle, moralistic punishment strategies could create cooperation in large groups. However, this mechanism will stabilize any norm that becomes common, whether adaptive or not (wearing ties to work is a humble example of the latter). (Richerson and Boyd, 2001, 195)

Surely, if Boyd and Richerson are right that even norms like, "wear a tie to work," have the function of social extinction through altruistic punishment we should not drive other groups social extinct insofar as they disregard such trivial norms.

As another example of revisionism, many utilitarians recognize that their theory makes extremely demanding claims on moral agents. If one must choose the action of those available that maximizes expected utility, one can argue that there will be little in the way of an enjoyable life.²¹ However, those

²¹Of course, one can accept or deny that utilitarianism is an excessively demanding theory (Kagan, 1991; Mulgan, 2001). My point is meant to be illustrative.

utilitarians simply deny that we should expect an enjoyable life – morality is extremely demanding (Singer, 1972)! One should not buy that latte, beer, or go see that movie since one could do far more good with that small sum of money. But this sort of denial of considered moral judgments is a limited strategy since we will need some such judgments to even motivate acceptance of a normative or metaethical theory. Wide reflective equilibrium (Daniels, 1979) occurs between our considered moral judgments, normative principles, metaethics, and the natural and social sciences. However, without our considered moral judgments (maybe even with) we will have more than one coherent set of normative principles, metaethics, and the natural and social sciences.

In addition, we must find relevant difference-makers as to why some considered judgments are accepted and others rejected. Otherwise, if we reject one judgment and not another such revisions will be ad hoc. Consider an example from the history of science, the case of Uranus' orbit. In the nineteenth century, Newtonian mechanics had successfully accounted for the orbits of most of the known planets. However, there was one particularly difficult case, Uranus. Newtonian mechanics incorrectly predicted Uranus' orbit. Astronomers concluded that either Newtonian mechanics was incorrect or they had made some calculational mistake. John Adams and Urbain Leverrier proposed that there was an unobserved planet of a certain size and distance beyond Uranus and they subsequently predicted its orbit. They found that the orbit of Uranus was as Newtonian mechanics predicts when conjoined with the additional auxiliary hypothesis. Eventually the unobserved planet, Neptune, was observed and Newtonian mechanics was recognized as successful. The auxiliary hypothesis, "There is a planet of a certain size and at a certain location which gives rise to certain perturbations in Uranus' orbit," was not ad hoc since one could test it independently of Newton's law of gravitation and laws of motion. Eventually, one could see Neptune with a telescope. We need some notion of "independent testing" in our moral theorizing as well. In the case of utilitarianism, it is clear that philosophers like Peter Singer accept considered moral judgments when they support their theory (e.g. you should save a drowning child when it merely ruins your shoes) but not when they challenge it (e.g. you should not have a latte, a beer with friends, or see a movie at the theater). Thus, I am skeptical that a radical revisionism is the right tact to take with regard to metaethics and normative moral theory. And specifically, I am suspicious of proponents of the natural goodness approach shirking our considered moral judgments in favor of their metaethics.

It is important to make one last point regarding Neo-Aristotelianism. Nothing I have said speaks against their most central ideas of (a) human needs are structured such that there is such a thing as human flourishing, (b) inculcating virtues, classical or otherwise, is the most effective means to advance human flourishing, and (c) and morality is fundamentally about human flourishing. Rather, Neo-Aristotelians should not expect to ground their naturalistic account of normativity in the selected effects functional approach but in some other (e.g. Humean) approach.²²

7 Conclusion

In this essay, I have scrutinized the natural goodness approach in the light of evolutionary biology. After presenting the approach, I argued that certain challenges regarding its commitment to species essentialism fail. Likewise, I argued that given our best account of natural norms, the selected effects account of function, leads to implausible ethical conclusions. This is so on an evolutionary biological or gene-culture coevolutionary account. In the end, the natural goodness appears to be neither natural nor good.

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²²Thanks to Richard Boyd for discussion on these points.

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