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978-1-108-47259-3 — What Biological Functions Are and Why They Matter
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Excerpt
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Introduction

This book is about what biological functions are and why they matter. I'll start off in reverse, by saying why they matter.

Functions matter because they're entangled in a dizzyingly wide array of discussions in philosophy and science. Functions lay at the *root*, as it were, of a great number of debates. For example, someone's ideas about what functions are have broad ramifications for thinking about the nature of health, disease, mental illness, mental representation, and mechanisms. Their stance on function can shape their understanding of how different subdisciplines of biology hang together, how to explain diseases, and how to study the human genome. Functions are folded into philosophical debates about biological information, biological trait classification, and even the nature of individuality. Without thinking philosophically about functions, it's almost impossible to think philosophically about nearly anything else in the biological world.

I'll walk through a handful of debates in philosophy and science to show how functions work their way in. Consider the philosophy of psychiatry. Specifically, consider the *basic* problem of philosophy of psychiatry: What *are* mental disorders? Related to that, when psychiatrists decide that a certain condition is a mental disorder, such as major depressive disorder or alcohol use disorder, or gender dysphoria, are they just expressing their values about those alleged conditions? Are they saying, for example, that alcohol use disorder is bad and we wish we could stop it? Or are they simply stating a value-free fact about it, the way you might state that, say, Merriam's kangaroo rat belongs to the genus *Dipodomys*? Or both?

One popular stance (of the naturalist variety) is that what makes something a mental disorder is that it stems from a *biological dysfunction* inside a person. If a man murders another because he's convinced his victim is a disguised alien, he probably has a mental disorder. Something in his brain isn't working *as it should*; there's a dysfunction in his thought processes. But that stance just invites further questions: What are functions? What are dysfunctions? And who gets to decide whose brain is functioning well and whose is functioning poorly? In my view, it's impossible to make progress on the nature of mental illness before getting clear on what functions are. (In Chapter 11, I'll come back to mental disorders.)

Turn to the philosophy of mind. Consider, specifically, the problem of *intentionality* or *aboutness*. What is it for a thought, which is inside my skull, to be about something outside my skull? What's the nature of this invisible relationship – if it's a relationship at all – that connects the two things? Starting in the 1980s, a group of philosophers began advocating for an evolutionary, naturalistic approach to intentionality. According to this view, that thing that gives me the power to have the thought, "Kampala is the capital of Uganda," is, at its most primordial, the same thing that gives a toad the power to register the presence of edible worms in its visual field. This viewpoint, known as *teleosemantics*, holds that mental representation is ultimately grounded in biological functions, which are, in turn, grounded in natural selection.

One of the real virtues of teleosemantics is that it shows how organisms can misrepresent their environments. When an organism misrepresents something – say, a bird misrepresents a crocodile as a log – there's a device in its brain that fails to perform its biological function; it's not responding *as it should* to predators. My own view is that teleosemantics is right but that many of its proponents go awry because they cling to an overly narrow conception of what functions are. This conception, *the traditional selected effects theory*, holds that a trait's function is just whatever it was selected for by natural selection (or a related selection process). The traditional selected effects theory generates spurious problems for teleosemantics, problems that have led some philosophers to turn their backs on it entirely. Once we clarify what functions are, some of these problems simply go away (see Chapter 12).

The functions debate doesn't just matter for philosophy. It matters for biology, too. It has deep implications for how we study the human genome. A few years ago, an unusually heated debate broke out between a group of geneticists. They began arguing about what proportion of the human genome is *functional*. One side of the debate, represented by the ENCODE Project Consortium, maintained that around 80 percent of the genome is functional. The other side of the debate, represented by the traditional "junk DNA" theorists, insisted that only 5–15 percent is functional. In response to ENCODE's (probably exaggerated) claims, the junk DNA scientists argued that ENCODE was ramming together two very different senses of "function," the *selected effects* sense and the *causal role* sense. They began citing the work of philosophers of biology, including my own, to support their contention. Thinking deeply about functions has immediate payoffs for the inner workings of biology itself, and not just for philosophers who like thinking about it. (And I mean "payoff" in the most literal sense; proponents of ENCODE claim that mapping these genomic functions will lead to major medical breakthroughs, a notion that plays heavily into the mechanics of funding. Claims about genomic function have a literal cash value.) I'll return to this project in Chapter 9.

I've indicated why functions matter, and I'll return to these debates in the book; now I'll say what they are.

This book sets out a novel theory about biological functions, the *generalized selected effects* theory (GSE). As the name suggests, it's related by descent to the traditional selected effects theory but drops some unnecessary limitations on the latter and draws out a principle that was buried inside it. The book also works out the implications of GSE for the problems I mentioned above. In particular, it recommends a novel way of thinking about mechanisms, mental disorders, and intentionality. It also reframes the debate about function pluralism, a topic that plays heavily into the ENCODE controversy. One of my main goals in this book – aside from convincing you that my theory is right – is to inject new life into the functions debate and show why it's so essential for thinking about other big problems in philosophy and science.

What exactly is GSE? GSE states that the function of a trait is whatever it did, in the past, that contributed to the trait's *differential reproduction or differential retention within a population*. It's an unabashedly historical account, since it claims that nothing in biology can have a function until it's gone through a few rounds of selection. GSE merges three key principles: differential reproduction, differential retention, and population.

The first part, differential reproduction, captures the core insight of the traditional selected effects theory – namely, that a trait can acquire a function because of how it caused the trait to multiply. The function of zebra stripes is to deter biting flies, since that's what helped the striped zebras out-reproduce the stripeless ones. The second part, differential retention, leads us out of the evolutionary realm and into the realm of development. Synapses in the brain, for example, don't reproduce. For them, success means persisting better than your neighbor. Hence the "generalized" part of the generalized selected effects theory: It includes everything the traditional selected effects theory does, and many other things in addition. It shows how antibodies can acquire new functions through antibody selection, how synapses can acquire new functions through synapse selection, and how behaviors and behavior dispositions can acquire new functions through operant conditioning.

Others have gestured toward the possibility of generalizing the selected effects theory to include development, but they were hindered in this task because they tried to fit all functions into the mold of differential reproduction. Millikan, for example, says that trial-and-error learning creates new functions because it helps behaviors reproduce over one's lifetime. That's nonsense any way you read it. Generalizing the theory requires more than a gentle tweak; it requires reconfiguring it from the ground up and showing why, on the basis of first principles, that reconfiguration is correct.

The third part, *in a population*, simply teases out a principle that's dormant in the very idea of selection. For selection always takes place within something like a population: that is, a group of individuals that impact each other's chances of survival, helping or hurting each other, as the case may be. The reason it's worth making that *implicit* commitment *explicit* is that it solves, at a stroke, various complaints people have lodged against the traditional selected effects theory as well as my own. Some have argued that the theory forces us to give functions to all sorts of things that don't deserve them, such as clay crystals, ball bearings, or piles of rocks, but since a pile of rocks isn't a population, its parts don't have functions.

The book is broken into three main parts: background, theory, applications. The first part consists of Chapters 1 through 3 ("Background"). These set out the foundation for the theory, and show why functions must be selected effects. In Chapter 1, I consider a puzzling feature of ordinary biological usage: namely, function's *explanatory depth* – sometimes function statements are causal explanations for traits. When biologists say that the function of the zebra stripes is to deter biting flies, for example, they're trying to explain *why zebras have stripes*. In Chapter 2, I argue that *if* functions are selected effects, they have explanatory depth. In Chapter 3, I argue the converse: namely, if functions have explanatory depth, then they're selected effects. If we take explanatory depth seriously, then the traditional selected effects theory, or something in its neighborhood, has no equal. I also defend the theory from a host of objections.

The second part of the book ("Theory"), Chapters 4 through 8, sets out GSE and explains why it's preferable to the traditional selected effects theory. It defends the generalized selected effects theory from various objections, it solves the problem of function indeterminacy, and it explains what dysfunctions are. In Chapter 4, I review how philosophers have tried to extend the traditional selected effects theory to other phenomena, such as learning, and I offer my diagnosis of where they went wrong – namely, they tried to fit all functions into the framework of reproduction or copying. Chapter 5 focuses on synapse selection, since it's a plausible case where functions come about simply by virtue of *differential retention* – one synapse outlasting another – even when there's nothing like reproduction happening. Chapter 6 presents, at long last, the generalized theory and defends it from seven objections, presented in order of increasing difficulty. Chapter 7 raises the problem of function indeterminacy and shows why solving it matters for biomedicine and teleosemantics. It defends the idea that proper functions are *proximal* functions. Chapter 8 says what dysfunctions are, and shows why GSE is preferable to other views on this score, such as Boorse's biostatistical theory of function.

The third part of the book ("Applications"), Chapters 9 through 12, applies GSE to problems in philosophy of biology, philosophy of medicine and psychiatry, and philosophy of mind. This is where the theory pays off in practical ways. Chapter 9 deals with the problem of function pluralism, which plays into the ENCODE debate, and says why the received version of pluralism, *between-discipline pluralism*, is wrong. Between-discipline pluralism tries to fit all biological uses of "function" into two categories, the *selected effects* sense and the *causal role* sense, and it tries to divide up biological disciplines, like genetics, neuroscience, and ethology, into two groups depending on which sense of "function" is more prominent. Chapter 10 delves into the topic of mechanisms and mechanistic explanation. It shows how mechanisms have a hidden, functional side, and once we draw out this functional aspect of mechanisms, we can make sense of how mechanisms break down. It also lays out a program for biomedicine: As a rule, don't look for mechanisms for diseases; instead, show how diseases come from breakdowns in mechanisms for functions. Chapter 11 draws out the implications of GSE for the philosophy of psychiatry and shows how one popular theory of mental disorder, the harmful dysfunction analysis, is wrong. If GSE is right, then many of the mental disorders that plague us, like generalized anxiety disorder, addiction, and even the delusions of schizophrenia, might not involve dysfunctions; maybe they're functional in their own right. Chapter 12 works out the consequences of GSE for teleosemantics, and argues that, if we accept GSE, we can solve a long-standing problem, the *problem of novel contents*. The chapter also defends a solution to a related problem, the problem of distal content.

This book is limited in one major way. It's not intended as a systematic survey of the vast literature surrounding biological functions, although I'll introduce many alternative theories along the way. I've already written that survey, *A Critical Overview of Biological Functions* (Garson, 2016), and found no need to do so again. For someone who wants an exhaustive catalog of various ideas people have entertained about functions for the last eighty years or so, that is the place to go, but for readers who want to know what functions are, and why they matter to other philosophical issues, this is the place to turn. The other can be seen as a helpful companion volume to this one.

I've drawn from numerous published, or forthcoming, papers and books. This work is indicated in the references section as Garson (2010; 2011; 2012; 2013; 2015; 2016; 2017a; 2017b; forthcoming a; forthcoming b; forthcoming c) and Garson and Piccinini (2014). But as far as the actual writing goes, this book was written entirely "from scratch." Its real virtue is that it has allowed me to distil the essential ideas of previously published work, expand them in certain ways, contract them in others, and put them together into a simple and, I hope, attractive whole.

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PART I

Background

CHAPTER 1

The Strangeness of Functions

Why do zebras have stripes? Biologists have argued about this since at least Darwin's time. Darwin himself dismissed the popular view that the stripes' purpose is camouflage: "The zebra is conspicuously striped, and stripes on the open plains of South Africa cannot afford any protection" (1871, 302). Others insist that stripes aren't there for camouflage but for cooling the animal (Larison et al. 2015). They think the black-and-white pattern chills the air around it. A third idea is that stripes play a role in social cohesion; the striped pattern draws zebras together into herds (Macdonald 2009, 689). A fourth possibility is that zebra stripes have no function at all (although I don't know of anyone who argues this in the literature). Maybe they're as biologically pointless as birthmarks, freckles, and chin clefts.

Recently, an American biologist, Tim Caro, threw his weight behind a newer idea (Caro et al. 2014; but see Harris 1930). He thinks the stripes' purpose is to deter biting flies. One particular family, the glossinids (commonly known as tsetse flies), is particularly troublesome, since it harbors a parasite responsible for African trypanosomiasis – the infamous sleeping sickness. Field and laboratory studies suggest that tsetse flies and other biting flies are averse to striped surfaces. Perhaps zebras use stripes to exploit this neurological quirk of the tsetse fly. Caro's hypothesis about the stripes' function is based on a mix of historical, geographical, and laboratory evidence, although the whole subject remains mired in controversy.

The parts and processes of the tsetse fly have functions, too. The tsetse fly is a family of bloodsucking flies that inhabit Central Africa, from the Sahara in the north to the Kalahari in the south. Unlike ordinary houseflies, it has a long, hollow proboscis. The tip of the proboscis is lined with tiny, sharp teeth, like a knife's serrated edge (see Krenn and Aspöck 2012, 111, Figure 8). The fly repeatedly prods an animal's thick hide until it draws blood. Its pharynx functions as a pump that sucks up the nutritious broth. A second pump shoots saliva into the wound in order to stop the blood from coagulating. The trypanosome parasite, *T. brucei*, lives in the saliva.

The parasite *T. brucei* has functions of its very own. It is one of many unicellular species of African trypanosome, and it resembles a tiny seahorse. It is the parasite responsible for sleeping sickness. Its coat contains millions of proteins called *variant surface glycoproteins*. The function of these proteins is to help *T. brucei* evade detection by the host's immune system (Horn and McCulloch 2010). The coat's genetic makeup is constantly changing: By the time the host's immune system learns to recognize one coat, *T. brucei* has morphed into another. As one geneticist described it to me, it is like changing hats, and the parasite changes its hat about once a week.

Functions are ubiquitous in the living world. Sometimes they harmonize; sometimes they clash. What are functions? At first glance, functions seem easy to understand. If functions are easy to understand, we should be able to give a clear and satisfying account of what they are. Instead, we find puzzles, and even contradictions, that drive us deeper into the nature of the living world.

When I ask biologists what functions are, I often get a similar response: "A trait's function is just what it does." Sometimes these biologists seem perplexed, and even mildly annoyed, to be asked a question like that. Hearts pump blood. That is what they do, so that is their function. Zebra stripes deter flies. That is what *they* do, so that is their function. The tsetse flies' labellar teeth puncture skin; *T. brucei's* glycoprotein coat tricks the host's immune system. Functions are simply doings.

Sadly, the biologists' simple account can't be right – for two reasons. First, traits do many things that aren't their functions. Noses help us breathe; they also hold up glasses, but their function is to help us breathe, not hold up glasses. Holding up glasses is a lucky benefit, or side effect, but not a function. Zebra stripes entertain safari guests, but that's also not their function. To use philosophical lingo, the fact that stripes entertain safarigoers is an "accident" and not a function. A good account of function should help us understand how functions and accidents differ.

Here's a second problem with the simple account that says a trait's function is just what it does. A particular instance of a trait – my stomach, your heart – can have the function of doing something even if it can't actually do that thing. If my stomach shuts down because of a drug overdose, it can't digest food. Yet it has the function of digesting food (it's a stomach, after all); thus it has a function it can't perform. It's "dysfunctional" or, if you prefer, "malfunctioning." Philosophers