

# **Agency in the Natural World**

**by**

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## Abstract

Human agency, like our other traits, is likely continuous with that of other organisms that have evolved on this planet. However, Modern Action Theory has focused almost exclusively on the agency of human beings, so it is not obvious how agency should be understood as a more deeply and broadly distributed, or more basic, biological type. The central aim of this thesis is to fill this gap by developing and defending an account of what I'll call "Biologically Basic Agency." In this work's first chapter, I establish a preliminary set of adequacy conditions drawn from broad consensus in Modern Action Theory and the needs of biological categorization. These adequacy conditions are then amended and supplemented over the course of the subsequent three chapters via critical discussion of two accounts of Biologically Basic Agency attempting to meet the adequacy conditions developed in Chapter 1. In Chapter 2, I show that Tyler Burge's (2010) account of Primitive Agency cannot be empirically refuted and therefore is trivial. In the third chapter, I argue that Kim Sterelny's (2003) account of the Detection System cannot serve as the evolutionary precursor to agency, because the kind of general evolutionary story Sterelny desires is empirically implausible. In the fourth Chapter, I continue my discussion of Sterelny's Detection System, because his basic idea that the simplest adaptive behavioral systems are "feature (or signal) specific" is deeply intuitive and popular amongst Philosophers and Cognitive Scientists. Focusing on the behavior of simple model organisms, I argue that, contra Sterelny and this intuition, these organisms move themselves through their environments toward a best overall place to be within one's environment relative to a number of (often competing) environmental features relevant to the biological needs of these organisms (typically utilizing sensory inputs corresponding with these various features of the environment). I call such behavior 'Utopic Behavior.' Finally, in Chapter 5, I defend Utopic Behavior as an account of Biologically Basic Agency, as it both meets the various adequacy conditions I have established and demonstrates a clear continuity between human agency and that of other organisms that have also evolved on this planet.

**Keywords:** Agency; Biology; Action; Action Theory; Primitive Agency; Detection System

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# Chapter 1.

## Introduction

### 1.1. Why are we here?

Action theory, since its modern inception in the late 1950s and early 1960s (particularly in the work of Elizabeth Anscombe (1957) and Donald Davidson (1963)), has focused very tightly on human agency (see, for example, Anscombe, 1957; Bratman, 1984; Davidson, 1963; Ginet, 1990; Harman, 1976; Mele, 1997, 2003; Searle, 1983). Donald Davidson (1982) provides the strongest illustration of this tight focus on human agency. He suggests that non-human animals do not possess the requisite mental states for producing actions because they lack language, which is required for possessing those mental states. And while his position on non-human agency might not be the common view, Davidson's importance to the development of early stages of action theory illustrates, I think, that this human-centric focus is emblematic of Modern Action Theory. Moreover, even when theorists have held that non-human animals like dogs, cats, and other large, behaviorally sophisticated animals are agents, what occurs, effectively, is that the account of agency developed by reflecting on human action is stretched to include such animals (see, for example, Anscombe, 1957; Dretske, 1988; Searle, 1983; Fodor, 1987).

Over the last 40 years or so, numerous attempts have been made to situate human mentality, cognition, emotions, and social behavior within a broader biological context (Barkow, Cosmides, & Bonner, 2003; Dennett, 1996; Donald, 1993; F. Dretske, 1988; Godfrey-Smith, 1996, p.; Griffiths, 1998; Millikan, 1984; Mithen, 1996). It is reasonable to believe that agency is also a behavioral type or cognitive feature that can be provided a deeper and broader biological contextualization, and that human agency can be set within this broader biological context to give us a more complete understanding of what sort of phenomena agency is. There is, therefore, good reason to take up the task of situating human agency within the broader biological context and developing a broader theoretical conception of agency as a biological kind. I will call such investigations and accounts of agency Biologically Basic Agency. It is not self-evident, though, what a broader or simpler conception of agency, biologically understood, should look like.

Consequently, inquiries into Biologically Basic Agency would do well to start with some broad constraints or guidelines, an initial framework that will guide and constrain formulations of an account of Biologically Basic Agency. To put it bluntly: we have to start somewhere.

There are two straightforward sources of a reasonable framework that can be readily identified in light of the basic project under discussion and its motivation. This motive is to situate *human agency* within a broader *biological context*. So, there should be some requirements and adequacy conditions regarding biological categorization, the establishment of biological continuities, and so on that will govern the development of agency as a biological category. Such a project will take as given the claims that human beings exhibit agency and that human agency is in some way continuous with whatever biological type is identified as Biologically Basic Agency. Furthermore, since Modern Action Theory is presently our most worked-out perspective on action and we might reasonably assume that our most developed theoretical work on the nature of action is not entirely mistaken (though it is focused on human agency), we would be wise to take on board the broadest areas of agreement within Modern Action Theory to generate adequacy conditions for an account of Biologically Basic Agency. After all, we would want and should expect our account of Biologically Basic Agency to “line up with” at least a portion of our current theoretical views on action. However, we cannot take on board all of the commitments found in Modern Action Theory. Indeed, as we will see shortly, an account of Biologically Basic Agency has to abandon any strong commitment to representational mental states like intentions, desires, and beliefs determining a behavior’s status as an action, which is central to modern action theoretic accounts of human agency.<sup>1</sup>

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<sup>1</sup> This is aiming at a “reflective equilibrium” approach (famously formalized by John Rawls (1971) with respect to the issue of agency as a biological phenomenon. We begin with some ideas that we have some good reason for accepting about the nature of the phenomena, and then see if those ideas line up with the world. Consequently, such starting ideas will be adjusted as an investigation makes progress. Of course, when taking such an approach, it has to be granted at the outset of such a project that some of our ideas regarding the nature of actions, as they are developed in Modern Action Theory, may have to be abandoned or substantively modified.



## 1.2. Establishing adequacy conditions for an account of Biologically Basic Agency

The first condition of an account of Biologically Basic Agency is that it should be offered in representation-neutral terms—the properties that are to mark a behavior as an action should not be formulated in terms of representational states, nor should representational states be ruled out. This is for two reasons. First, we do not yet know “how far down” or how broadly agency will be distributed in nature. It may, as a biological category, be fruitfully extended all the way to single-celled organisms that many would not believe possess representational capacities of any kind, which I think is a natural, intuitive position. Second, we do not yet know exactly which organisms have representational capacities and which do not. Some philosophers—like Ruth Millikan (1989a)—have argued that representational capacities of the most elementary sort are found in single-celled organisms—or, at least, “aboutness” is. Moreover, there are those who posit anti-representationalist theories of mind, which hold that representations (at least as stable, enduring, mental states that are the objects of thought) do not exist, and so representations are not present and relevant to action anywhere in the biological world.<sup>2</sup> Consequently, our first constraint on an account of Biologically Basic Agency is that it should be formulated in representation-neutral terms. With this very general guideline established for virtually any attempt at developing an account of Biologically Basic Agency, I will now turn to those derived from our more anthropocentric motives.

Within the two most entrenched camps in Modern Action Theory—causal action theorists and non-causal action theorists—goal-directed motor behavior is taken to provide the prototypical instances of action to be explained.<sup>3</sup> They agree, then, that the following kind of explanatory framework is appropriate of such prototypical instances: “Fred went to the fridge in order to get a Cactus Cooler.” The motor behavior—going to the fridge and presumably rummaging around in it—is explained by appeal to a goal, having

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<sup>2</sup> For an example of an anti-representationalist view see Alva Nöe's (2004, 2010) views.

<sup>3</sup> Annette Baier (1981) has noted and resists this almost exclusive focus and recommends stronger consideration of mental acts. I am, though, on the side that takes motor action as the primary and foundational kind of action.

possession of a Cactus Cooler.<sup>4</sup> The second constraint or guideline we can identify on accounts of Biologically Basic Agency is that actions be “goal-directed movement” of some kind. I say “movement” here because “motor behavior” is typically reserved for discussing organisms with nervous systems (Adolph & Franchak, 2017; Clark & Oliveira, 2006). As I noted above, we do not want to decide too much at the outset regarding how “far down” or how “broadly” agency will be distributed on the phylogenetic tree.

Following this point, not everything a human being does is an action. There are all manner of twitches, metabolic processes, and autonomic responses that are not numbered amongst the class of actions of modern action theories. This aligns with what I think is a common intuition, that actions are a “special” kind of behavior. So, the third constraint on accounts of biologically basic action is that an account of Biologically Basic Agency should distinguish action as a distinct subclass of the larger category of behavior. In Modern Action Theory, this distinction is made on the basis of which behaviors are explicable in terms of representational states like intentions, beliefs, desires, etc. But since an account of Biologically Basic Agency should be representation-neutral, some other property or set of properties will have to be identified for distinguishing behaviors that are actions from behaviors that are not.

Finally, given the motivation to situate *human* agency within a broader *biological* context, a final dual-aspect constraint emerges for developing an account of Biologically Basic Agency. An account of Biologically Basic Agency should identify Biologically Basic Agency as a biological type that conforms to a standard biological classification scheme, *and* we should plausibly establish that human agency is either continuous with this category or that it belongs to it. I think that how effectively an account of Biologically Basic Agency is able to situate human agency within the stipulated biological category of

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<sup>4</sup> Where causal and non-causal branches of action theory diverge is on the matter of how goals, as represented by mental states like intentions, explain these behaviors. In the case of the causal action theorist, the mental state causes the motor behavior, thereby explaining the occurrence of the behavior (see Davidson, 1963 for the classic presentation of this position). For the non-causal theorist, actions are, in some way, non-causally explained by appeal to goals, and intentions are actions. Behaviors that are not so explained are not actions. Exactly how these non-causal explanations are to be understood in a positive sense has been difficult to discern. Negatively, however, the position is more readily understood. The non-causalist’s point is more or less that teleological explanations—appeal to goals, intentions, etc.—cannot be sensibly reduced to a naturalistic vocabulary to which our notions of efficient causation properly apply (for good examples of this argument see Sehon, 1994, 1997, 2005; Taylor, 1964).

agency will be the strongest marker of the view's plausibility. (This assumes, of course, that it has met the other constraints enumerated in this section.)

### **1.3. Two accounts of Biologically Basic Agency and two types of biological category**

Recently, there have been two prominent accounts that take these basic constraints on board in developing accounts of Biologically Basic Agency—Kim Sterelny's (2003) account of the "Detection System" and Tyler Burge's (2009, 2010) account of "Primitive Agency." Each of these views, though, takes a different perspective on how agency will function as a biological category—in what ways agency will be "put together" as a category or, in another sense, the nature of the continuity between "simpler" kinds of agency and "more complex" kinds of agency.

#### **1.3.1. Kim Sterelny and Strong Evolutionary biological categories**

Kim Sterelny (2003) (whose ideas I will discuss in Chapters 3 and 4) offers a version of what I call a "Strong Evolutionary" perspective on how agency functions as a biological category, which I call a "Common Trajectory" story. A Common Trajectory story identifies a simplest biological trait that has appeared in many different lineages but does not hold that all instances of this trait are inherited from the same common ancestor. (This basic trait would be an instance of convergent evolution.) The "strength" of this evolutionary story is manifest in that such a story will claim that all more complex and sophisticated developments of this basic trait will follow the same set of evolutionary stages in response to the same broadly characterized selection pressure. Effectively, there is an evolutionary track from the simplest to the most complex instantiator of the trait that all instances of the trait will have traversed to some degree. Some organisms will have made no progress with respect to this trait beyond that which is found at the beginning, while some will have developed the most sophisticated type, and all those that fall in between will do so because they have moved along the track toward the most complex type from the simplest to some degree. Kim Sterelny's (2003) situating of human agency within a broader biological framework follows this pattern. The simplest kind of agent (i.e., the biologically basic agent) is the "Detection System"—a behavioral system that produces a single, feature-specialized behavior that is triggered by a single "environmental signal" that correlates with the feature of the world the behavior is

supposed to target. All more sophisticated kinds of agency are to evolve in a regular, uniform fashion from this simplest type. Detection Systems next become “Robust Tracking Systems.” Robust Tracking Systems can use more than one environmental signal (correlating with the target feature) to generate the appropriate behavior. After the Robust Tracking System, behavioral responses become “decoupled” from environmental signals via two pathways, both of which must be followed to reach the most sophisticated kinds of agency on Earth—the intentional agency possessed by human beings. These paths are that a signal can “trigger” more and more distinct behavioral responses, and that a single behavior can be applied to more and more distinct signals (and so features of the environment). This decoupling of specific behavior to a specific signal, as I noted, leads to the fully decoupled agency enabled by human intentional agency—we can apply any behavior in our repertoire to any environmental signal and any feature of the environment. Agency evolves along this track because of a single selection pressure, environmental translucence: it is not always the case that a signal indicating the presence of some feature of the environment is reliable, and sometimes acting on such a “false” signal can lead to death or serious injury.

The alternative kind of Strong Evolutionary perspective is what I am calling a “Common Ancestor story.” On such an approach, organisms or their traits are grouped together in virtue of common descent from a single ancestor organism that possessed this trait. So, in the case of agency, there would be some organism—say a single-celled prokaryote—that had the trait of agency (whatever that trait amounts to), and all other organisms (and so species) that also possess the trait of agency inherited it from the first organism that possessed this trait. All agents are agents—are grouped together—because they all inherited agency from a common ancestor that possessed it. This is the way in which we group tetrapods like us together with reptiles, birds, and amphibians. We are all tetrapods because we are all descendants of the same tetrapod (four-limbed—literally four footed) ancestor.

### **1.3.2. Tyler Burge and Good Trick biological categories**

The second broad biological categorization scheme is employed by Tyler Burge in his account of “Primitive Agency” (upon which I will focus in Chapter 2). This second

approach to biological categorization consists of what I call Good Trick accounts.<sup>5</sup> Such accounts identify a generally characterized biological strategy exhibited by many organisms and are instantiated by these organisms in a myriad of ways, some of which will be more complex and sophisticated than others. These strategies do not presuppose common ancestry or substantively common selection pressures. They are, effectively, strategies that are a good idea for many organisms to adopt, given the needs that organisms tend to have or the circumstances that organisms tend to face. Examples of such biological kinds are camouflage (morphological adaptations for avoiding detection or recognition by other organisms), heterotrophy (eating for energy), and autotrophy (making one's energy one's self as in photosynthesis). For biological kinds like camouflage or heterotrophy, we do not have or need evolutionary relatedness amongst the members of the category, nor do we need a unified evolutionary story regarding how such kinds will evolve, in sequence, from similar "more basic" ancestral types.<sup>6</sup>

Burge does not explicitly declare his thinking about the kind of biological category agency constitutes. (Sterelny, by contrast, makes it very clear he is offering an evolutionary account.) But I believe Burge's account of Primitive Agency (2010) fits this model for a number of reasons. First, he claims that Primitive Agency is conceptually and "phylogenetically prior" (p. 327) to the kinds of representational agency commonly attributed to human beings. However, he does not suggest that he believes there is a unified sequence of steps that all agents will take on the path toward representational agency (beyond that of acquiring representational capacities and that these capacities, like basic sensory abilities, will be integrated into the means by which organisms control their behavior). Moreover, Burge appears to hold that representational agency, like that supposedly found in us, is a sub-category of the primitive type—the features that representational actions have that place them within the class of actions will be those that also make the behavior of single-celled organisms belong to the class of actions.

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<sup>5</sup> A term borrowed from Daniel Dennett (1996) used for identifying similar commonalities amongst the traits of organisms.

<sup>6</sup> See, for example, Mele, 1997; Wilson & Shpall, 2016.

## 1.4. Moving forward

To begin the discussion of Biologically Basic Agency in this thesis, we now have the following adequacy conditions for an account of Biologically Basic Agency:

1. That an account of Biologically Basic Agency be formulated in representation-neutral terms.
2. That Biologically Basic Agency identifies a behavioral type that is “goal-directed motor behavior or movement” akin to the way this is done in Modern Action Theory.
3. That Biologically Basic Agency be a distinct subset of the class of behavior, i.e., not all behavior is action.
4. That an analysis of Biologically Basic Agency should fit a standard classification scheme for biological traits. There are two broad classification options here.
  - a. The first is to offer what I have called a Strong Evolutionary story, of which there are two varieties: i) A Common Ancestor Strong Evolutionary story is one that identifies a common ancestor agent from which all later agents have evolved or descended (and so one possesses agency in virtue of inheriting that trait from a single common ancestor). ii) The Common Trajectory type of Strong Evolutionary story, like that offered by Kim Sterelny (2003), identifies a common, diversely evolved “simplest” functional type and then claims that the same general selection pressure will produce the same evolutionary trajectories—the same stages through which all more sophisticated agents will progress—for all instances of the diverse descendants of the diverse instantiators of this simplest version of the biological trait.
  - b. The second approach is to identify a broad, functional category that has evolved in various lineages in various ways because it is a Good Trick or useful thing to do in virtue of being a living organism and having the needs that living organisms often do. A Good Trick account, though, does not presume a common ancestor from which all instances of the biological trait have evolved (as in a Common Ancestor variety of a Strong

Evolutionary story). Nor does it presume that there is a uniform set of evolutionary stages that all instances of the type will have followed from a simplest (independently evolved) version of the type (as in a Common Trajectory version of a Strong Evolutionary story). Biological traits like camouflage, heterotrophy, and autotrophy constitute examples of this sort of biological classification scheme.

### **1.4.1. Roadmap**

With a reasonable framework of adequacy conditions for accounts of Biologically Basic Agency established along with the strategies one can employ to generate a plausible and coherent biological category of agency that can then be used to establish the continuity of human agency with the agency of other organisms, I can now set out the argumentative goals of the dissertation. The aims are twofold, but integrated. The first is to critically evaluate Burge's (2009, 2010) account of Primitive Agency and Sterelny's (2003) account of the Detection System (and its status as a plausible evolutionary progenitor of all more sophisticated agency) over the course of Chapters 2 through 4 in order to establish weaknesses in these accounts. These weaknesses will then be used to generate further constraints on accounts of Biologically Basic Agency and to further refine the constraints on accounts of Biologically Basic Agency already identified above.

The second aim, addressed in Chapter 5, is to use the criteria developed and modified throughout Chapters 1 to 4 along with other results of the critical discussions of Burge's and Sterelny's theories to develop an initial proposal for an account of Biologically Basic Agency. I will posit and defend the idea that Biologically Basic Agency is "Utopic Behavior"—the ability to move one's self through one's environment toward a "best overall place to be" within one's environment relative to a number of (often competing) environmental features that are relevant to the biological needs of the organism (typically utilizing sensory inputs corresponding with these various features of the environment). The aims of this work will be accomplished via the following steps.

### **1.4.2. Chapter 2**

In Chapter 2, I begin by taking up the evaluation of Tyler Burge's notion of Primitive Agency and evaluate its promise as an account of Biologically Basic Agency. Burge's

account has two interlinked components. The first is a set of exemplar behaviors we intuitively judge to be actions. The second is a formulation of the properties that actions have in common—that they be functional, whole-organism behavior that issues from central behavioral capacities. Burge's account of Primitive Agency, while holding a degree of intuitive appeal, is difficult to interpret, whether that be in terms of organism-environment interactions or in terms of the mechanisms that organisms utilize to produce the behaviors Burge judges as actions. This feature makes Burge's view virtually impossible to refute on the basis of whether or not Burge's account squares with the empirical findings regarding organism behavior.

The lack of precision in Burge's account entails that his view can be made consistent with any theory of action—from those that restrict action to behavior produced by organisms that have certain kinds of representational states like desires, intentions, and beliefs to those that attribute action to any object in the world that moves. This, effectively, renders Burge's account of Primitive Agency trivial—it can be interpreted so as to be compatible with any account of agency, even those (representationalist) accounts that Burge wants to undermine and reject by identifying Primitive Agency.

The most important part of this discussion for the argumentative path of this work is that it establishes a further constraint on accounts of Biologically Basic Agency. Accounts of Biologically Basic Agency need to be formulated such that they can be refuted on the basis of the empirical findings regarding the behavior of organisms.

### **1.4.3. Chapter 3**

In the third chapter, I introduce Sterelny's conception of the Detection System as the simplest kind of agent from which all other more sophisticated kinds evolve (and therefore as a Strong Evolutionary story of the Common Trajectory variety).

Sterelny's conception of the Detection System—as formulated—will not do as an account of Biologically Basic Agency, for three reasons. The first is that the examples of Detection Systems cover too great an evolutionary range. Bacterial movement in response to sensing chemical gradients is placed at the same evolutionary level as the memory-mediated cache retrieval of birds. It is highly unlikely that the Detection System of the bird and the bacterium will evolve along the same track, given that memory is both



functionally distinct from basic sensory capacities and is a much later evolutionary development. The second reason is that the Detection System needs to be widely distributed, i.e., typical of behavior in the organic (or at least the animal) kingdom. This, though, is not so. The research tradition Sterelny draws upon for many of his examples of Detection Systems sought to identify a number of single-purpose, highly stereotyped behaviors (which were called Fixed Action Patterns); it has now been shown to be incorrect. Organism behavior is not typically “feature-specialized,” and such specialized, stimulus-locked behavior is taken to be indicative of dysfunction within an organism rather than indicative of typical function. Third, and finally, problems identified for the Fixed Action Pattern view regarding the evolutionary relationships between Fixed Action Patterns help demonstrate that Strong Evolutionary stories of the Common Trajectory variety are not plausible with respect to highly general functional types like the Detection System (and may not be plausible for any functionally identified biological trait, and at a minimum need to be established on a case by case basis).

#### **1.4.4. Chapter 4**

The notion that the simplest adaptive behavioral systems will be special-purpose—produce a single, specialized behavior in response to a single feature of the environment—is deeply intuitive. So, in Chapter 4, I investigate the possibility that Sterelny's Detection System can be modestly reformulated so as to fit a Common Ancestor type of Strong Evolutionary story. In doing so, I restrict Detection Systems to the “simple” behavior of “simple” organisms. If this is right, then we should see Detection Systems in single-celled organisms or simple animals (either of which could plausibly play the role of a common ancestor from which all agents will evolve). To test this hypothesis, I apply the Detection System model to two model organisms and their behavior that would, at first blush, plausibly be seen as clear examples of Detection Systems—the phototactic behavior of the freshwater alga *Chlamydomonas reinhardtii* and the diel vertical migration of the tiny freshwater crustacean *Daphnia pulex*.

This investigation shows that such organisms do not produce single, specialized behavior in response to the presence of some specific feature of the environment. Rather, organisms like *Chlamydomonas* and *Daphnia* produce, in their phototaxis and diel vertical migration, what I call Utopic Behavior. Even very simple organisms like *Daphnia* and *Chlamydomonas* use multiple sensory inputs related to multiple features of

the environment that are relative to their survival or self-maintenance to guide their movement through the environment toward a “best overall place to be” relative to varied and often competing biological needs. In effect, a balance is struck between competing interests by adopting a position in the environment that allows the organism to “trade off” between its various needs and the degree to which the needs are pressing at the moment. Furthermore, given that both *Chlamydomonas* and *Daphnia* serve as model organisms in biology, it is reasonable to assume that this kind of behavioral structure is widely distributed amongst organisms of similar complexities and similar habitats. Utopic Behavior, therefore, suggests itself as an analysis of Biologically Basic Agency.

### 1.4.5. Chapter 5

In Chapter 5, the goal is to show that Utopic Behavior provides a promising account of Biologically Basic Agency. The first step is to establish that, at a minimum, an account of Biologically Basic Agency as Utopic Behavior meets the adequacy conditions established throughout the first four chapters.

The condition that an account of Biologically Basic Agency should be offered in non-representational terms is met quite straightforwardly, as the Utopic Behavior of *Daphnia* and *Chlamydomonas* can be easily described in non-representational terms. Moreover, Utopic Behavior is an empirically testable account of Biologically Basic Agency. If it were to offer a Common Ancestor grounded biological type, we should expect to see a single, single-celled organism from which all organisms that can move around their environments (like *Daphnia* and *Chlamydomonas* can) inherit this ability. But, as it turns out, the ability to propel one’s self throughout one’s environment has evolved many times in many ways on this planet. Further, if Utopic Behavior were to provide a Good Trick kind of biological category, we should expect the general functional description of this behavioral type to accurately characterize the behavior of organisms in many different lineages, and be, on balance, adaptive. And this is indeed what we see. Many organisms use many different locomotory mechanisms, sensory mechanisms, and internal organizations (like nervous systems of various types) to implement this type of behavior. (So, if it failed to be the case that this was a broadly observable functional type, there would be good reason to doubt that Utopic Behavior describes a Good Trick biological category, and so would very likely not describe any plausible biological category.)

With the testability of Utopic Behavior established as a broad, functional biological type involving movement around the environment, it is easy to establish that it describes a kind of goal-directed movement. Meeting this adequacy condition does not get us very far, though, because simply being a kind of goal-directed movement does not allow us to distinguish Utopic Behavior from behavior in general. It does not identify properties that Utopic Behavior has that are not possessed by all instances of behavior. This is because every behavior of an organism is going to involve movement on some part of the organism in response to a multitude of interacting environmental circumstances, both internal and external. The distinctiveness of Utopic Behavior, though, is established by the fact that it inherently involves movement around the environment—changing the location of one's body within one's environment in order to achieve or maintain an advantageous position within said environment.

This argumentative turn, however, is not the clear success it might appear to be. Relying on the capacity to alter one's location in one's environment to distinguish Utopic Behavior from behavior generally could raise the concern that this distinction, and so Utopic Behavior as an account of Biologically Basic Agency, are *ad hoc*—that I am only defending this view because it works. Do we have reason for believing that Utopic Behavior offers a promising account of agency beyond simply meeting the various adequacy conditions I have identified, particularly that of being distinct from behavior generally?

In addressing this concern, I appeal to the foundational motivation for the kind of project under examination and attempted in this thesis—that the aim is to situate *human* agency within a broader biological framework. The feature of an account of Biologically Basic Agency that will allow us to evaluate whether a theory of Biologically Basic Agency is good once it has met the adequacy conditions identified above will be how well it establishes a continuity between human agency and the agencies of other creatures postulated by the theory. And indeed, Utopic Behavior does enable the establishing of such continuity. The prototypical cases of action theorized about in Modern Action Theory—human motor actions are instances of Utopic Behavior—share the same properties that make the behavior of *Chlamydomonas* and *Daphnia* actions (as stipulated by the Utopic Behavior view). Therefore, human actions are instances of Utopic Behavior like those of *Chlamydomonas* and *Daphnia*, and thereby belong to the same Good Trick biological category.

## Chapter 2.

### Primitive Agency

#### 2.1. Introduction

Tyler Burge, in his book *The Origins of Objectivity* (Burge, 2010),<sup>7</sup> offers a version of what I have called Biologically Basic Agency,<sup>8</sup> which he calls Primitive Agency. Primitive agency is intended to characterize non-representational relationships between organisms and their environments that fulfill “animal needs and activities,” which will “phylogenetically and constitutively” enable perception and then other types of representational capacities to emerge. Accordingly, “such relations ground the explanatory methodology of perceptual psychology—motivating it to relate its explanations to biological explanations, particularly explanations in zoology and ethology” (Burge, 2010, p. 327). In other words, the empirically informed explanation of perception will be grounded in the broader explanatory framework provided by zoology and ethology—biological sciences that work to explain the inner workings of organisms and their behavioral and non-behavioral interactions with the environment.

Commensurate with these aims, Burge is of the opinion that agency reaches quite far down the phylogenetic tree, likely extending all the way to single-celled organisms like paramecia and amoebae. As a consequence, Burge places his perspective on agency in opposition to any picture of agency that “hyper-intellectualizes” (p. 327) the concept by holding that representational states like beliefs, desires, intentions, etc. are necessary for the production of action. The “hyper-intellectualized” views, therefore, limit agency to humans and other organisms psychologically similar to us and would deny that it could extend to single-celled organisms of the sort Burge wants to include.

However, despite these differences in root theoretical orientation, Burge *does* agree with the “hyper-intellectualizers” of agency on one issue—he also sees action as a proper subset of behavior. So, like the “hyper-intellectualizing” theorist, he seeks to provide an

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<sup>7</sup> And in Burge (2009), where the relevant textual passages are usually word for word identical.

<sup>8</sup> See Chapter 1.

account of (primitive) agency that distinguishes actions from behaviors that do not count as actions—what I will call “mere behaviors.” The “hyper-intellectualized” view, of course, has a fairly clear and ready-to-hand distinction between action and mere behavior. Actions are those behaviors properly explained by certain kinds of representational mental states—beliefs, intentions, desires, wishes, wants, etc. Mere behaviors are those that are not explained by these kinds of mental states. Since Burge rejects this as an exhaustive analysis of agency, and given his other commitments, he is after (at a minimum) a biologically grounded, non-representational account of Primitive Agency that differentiates behaviors that properly count as actions from those that do not.

In this chapter, I will show that Burge’s views on agency do not provide a biologically grounded, non-representational account of Primitive Agency that is capable of distinguishing between behaviors that are actions and those that are not. This is because his view consists of two parts that cannot be properly reconciled. These parts are: 1) a set of prototypical examples of action and mere behavior that are to drive<sup>9</sup> the account, and 2) a characterization of the properties that when instantiated by a behavior, render that behavior an action as opposed to a mere behavior, and so sort the exemplars into their appropriate categories. Burge’s characterization of Primitive Agency, in its most straightforward empirical (particularly biological) interpretations, cannot sustain a distinction between his exemplars of action and mere behavior, or in the class of behavior generally; all behavior counts as action. Moreover, when his characterization is adjusted to align with his driving exemplars of action and mere behavior (and processes that are not behavior), the account collapses into a representational account of agency of the kind he wants to reject as exhaustive. Consequently, Burge’s discussion of Primitive Agency does not provide an empirically grounded *non-representational* account of agency. At most, Burge’s discussion offers part of an account of such agency—a list of archetypal exemplars of action and a suggestion as to how to theoretically distinguish them—but Burge’s remarks do not reveal why such behavior should count as action and others should not.

This assessment, though, could be resisted by pointing to Burge’s explicit commitment that an account of Primitive Agency will be “example driven,” and that this commitment is

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<sup>9</sup> By “drive” I, and I think Burge, mean provide the examples that give Burge his starting point for thinking about action and agency, and are to be accommodated by whatever is developed in (2).

derived from, and therefore is consistent with, his broader views concerning how we determine a concept's proper extension. So, even though Burge has not offered a complete account of what explains the difference between actions and mere behaviors, he has provided the exemplars and a "rough" characterization that point the way toward the eventual complete (or nearly complete) account. In part, this defense is an appeal to the virtues of establishing broad, theoretical consistency. But more substantively, the defense is that Burge's account, despite being incomplete, has almost certainly got something right or is on to something, because there is *some* kind of agency that does exist in the world, and his exemplars, along with his characterization of the properties that make a behavior an action, have gestured to this agency that is really in the world. So, Burge cannot be criticized for not yet accounting for why some behaviors are actions and some are not. However, even if we grant Burge's broad picture of conceptual development, this move ultimately has the effect of making Burge's account correct no matter how the empirical findings turn out, and will therefore be consistent with any worked-out theory of agency, even ones that reject many of Burge's initial core commitments—i.e., his account is trivial.

These findings regarding Burge's view enable the identification of a two-factor constraint on any theory of Biologically Basic Agency. In the first place, if one is going to offer a biologically grounded account of agency, one's account needs to be the sort that can be rejected on the basis of contrary biological evidence or a lack of coherence with the empirical picture one is relying upon. Failure to adhere to this guideline risks making one's account of Biologically Basic Agency trivial—one that is "not even wrong." In what follows, I will first provide a detailed and necessary overview of Burge's thinking about how Primitive Agency and behavior develop and will then discuss the difficulties that land Burge's account of Primitive Agency in this position.

## **2.2. Burge's account of Primitive Agency and the challenges of interpretation**

Burge's account of agency has two constructive elements. The first element derives from a theoretical constraint: that "the notion of primitive individual action is... driven by examples" (p. 331). This means that Burge's conceptualization of agency begins with examples of behavior that one would judge (pre-theoretically) to be prototypical instances of action or exemplars of action. He thinks that predating, swimming, eating,

mating, navigating, parenting, and other unnamed behaviors provide such exemplars (p. 327-328). These are, according to Burge, behaviors that we judge to be “inherently active.” So, the swimming of a paramecium, a human being, or a fish, since they are all instances of the same inherently active behavioral type (swimming), will each count (at least initially) as actions (p. 331). There will, of course, also be complementary exemplars of behaviors that are not actions (mere behaviors).

The second element of Burge’s account of Primitive Agency is an identification of the characteristics common to actions. Burge tells us:

I think that the relevant notion of action is grounded in *functioning, coordinated behavior* by the *whole organism*, issuing from the individual’s *central behavioral capacities*, not purely from subsystems. Coordination is meant to imply that the behavior must issue from central capacities, in effect coordinating subsystems, or coordinating central capacities with their peripheral realizations. The schematic account in this paragraph is not a definition. It nevertheless guides my conception and helps unify the examples (p. 331).

The first thing to be clear about is that this characterization is not intended to offer a definition—to provide necessary and sufficient conditions—for Primitive Agency. It is, though, supposed to “[help] unify the examples” of action Burge identifies, and it “guides [his] conception” of agency and action. This means that this characterization should identify the properties common to actions that mere behaviors do not possess, and thereby provide the reasons, explanation, or grounds for why some behaviors are properly sorted as primitive actions and others are not. Given that we are looking at the biological world here, borderline and uncertain cases are inevitable, but we should have the resources to distinguish most cases. The second thing to note about this description is that the property of “issuing from the individual’s *central behavioral capacities*” (or “coordination by, or with, the individual’s central capacities”)<sup>10</sup> is the condition doing the lion’s share of lifting and separating of action from mere behavior. However, why this is so may not be immediately obvious; a brief examination of Burge’s conceptualization of behavior will help draw this point out. I turn to this task in the next section.

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<sup>10</sup> It appears, for Burge, that mere behaviors cannot be coordinated. Rather, coordination only occurs when a behavior issues from central capacities, being “coordinated with” or “by” said capacities. This, then, makes listing “coordination” as a separate property that an action can have redundant, since it cannot have that property independently of issuing from central capacities.

## 2.3. Burge's take on behavior

All behavior, for Burge, is “imputable” or “attributable” to the whole organism—so all behavior is (almost trivially) “whole organism behavior.” In contrast, a process produced by a part or subsystem of an organism that can only be properly imputed to that part or sub-system is not a behavior. The “classical reflex arc,” which “[i]n relatively complex animals [...] does not even go through the central nervous system,” is an example of a non-behavioral process—so too are “muscle spasms, the firing of neurons, saccades by the eyes. Such events are normally not imputed to individuals” (p. 333). So, on Burge's view: I turn my head to look in the direction of a noise. Turning my head depends on a number of my subsystems—my vestibular system, my motor system, my visual system, etc. The process (turning my head) is attributed to me, the individual (not to the subsystems that participate in the production of this process) and so this process is a behavior. However, the eye saccades that occur while I am turning my head would not count as behavior, because they are only attributable to a part of me—the subsystem that controls it.<sup>11 12</sup>

Moreover, behaviors—in addition to being imputable to the whole organism (or individual)—will typically be functional; they will contribute to “Survival for Mating” (p. 326)<sup>13</sup>. A reflexive “Schreck reaction,”<sup>14</sup> like a deer's freezing in the headlights, and behaviors like shivering, coughing, and sneezing are “Passive Behaviors” (p. 332, 333) that have functions. “Schreck reactions” have the function of “shutting down the

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<sup>11</sup> Burge does not distinguish agency from not-agency in the case of reflex-like responses (inflexible responses) in virtue of their inflexibility, as is the case for the many (see Chapter 1). Indeed, he thinks that at the more basic levels agency may well be “just reaction” (p. 330). Rather, reflexes are not candidates for actions because they are not available to “central coordinating agency” (p. 333). This provides some further evidence that central behavioral capacities or central coordination is the notion—or cluster of notions—doing the heavy lifting in Burge's characterization of agency.

<sup>12</sup> Burge also has a somewhat idiosyncratic conception of behavior—plants, on his view, do not exhibit behavior. This is not the view among biologists—see, for example, (Leopold, 2014, 2014; Satter & Galston, 1973).

<sup>13</sup> This is Burge's gloss on the biological function of a trait.

<sup>14</sup> This is Burge's term of art. This “Schreck Reaction” is not a concept employed in the ethological literature. There are “Alarm Reactions”—German “Schreck Reaktion”—which are somewhat similar, but they typically involve unintended signaling between organisms, like the chemicals released by an injured fish into the water that warn other fish of danger (Døving & Lastein, 2009), and spark flight behavior.



individual's central behavioral capacities"—i.e., of shutting down agency (p. 332). Shivering maintains core body temperature, while coughing and sneezing clear out airways. Similar points can be made for many other "whole organism" behaviors like breathing, sweating, etc.<sup>15</sup>

The point to note here is that these exemplars of "passive" or "mere" behavior are functional behavior by the whole organism (indeed, it is being attributable to the whole organism that makes a process a behavior). The only feature they lack is "issuing from" or "being coordinated by/with central capacities." As Burge says, "[behaviors like this] are operations of peripheral systems that are not normally products of coordination with central behavioral capacities. They are reflexive, peripheral processes" (p. 332)—and therefore, such behaviors are not actions.<sup>16</sup> On the premise that the property in Burge's characterization of primitive action that will determine whether a behavior properly counts as an action is that of "issuing from central behavioral capacities," I now move on to showing why this feature of Burge's account generates serious problems for his view.

## **2.4. The beginning of the problems for central behavioral capacities and Burge's account of Primitive Agency**

The importance of "issuing from central behavioral capacities" in distinguishing actions from mere behavior creates deep difficulties for Burge's account, because it is not evident what Burge means to pick out with central behavioral capacities. He does not offer a biological, ethological, etc. cashing out of what such capacities would be in organisms generally or for the single-celled organisms he is most concerned to cover with his account. Consequently, it is not readily apparent which common (biological, ethological, etc.) properties (specific or general) are supposed to be instantiated by the

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<sup>15</sup> See, for example, Humbert & German, 2013; Moreira & Mulkey, n.d.; Shibasaki, Wilson, & Crandall, 2006.

<sup>16</sup> Such behavior could count as active under other circumstances, like intentionally coughing (p. 332) to attract attention but is not typically active.

swimming, eating, etc. of paramecia and amoebae such that these behaviors count as actions like they, presumably, do in humans.<sup>17</sup>

However, despite the fact that Burge is not explicit about what central behavioral capacities amount to in amoebae and paramecia (or organisms generally), he does not leave the matter entirely unilluminated. He does identify the biological properties that distinguish central processes and peripheral processes in organisms that have central nervous systems as a guide for understanding agency in simpler organisms. Burge says:

In the cases of larger animals, there is usually a fairly clear distinction between central and peripheral processes that correlates roughly with an anatomical distinction between processes that are controlled by the central nervous system and processes that are not. One can make a start at analogous points even for simple organisms like paramecia that lack a central nervous system. Eating involves a unitary process that involves the whole organism (eating itself, and rotation of the animal body so that the side that has the gullet opening faces the food), as well as operations imputable purely to its subsystems (expansion of the gullet). By contrast, protein transfer through the membranes of the paramecium is not a process that engages the unified behavior of the whole animal (p. 333).

Here again Burge emphasizes the coordination or unification that “issuing from central capacities” brings to a behavior. For organisms with central nervous systems, then, the behaviors that are controlled by the central nervous system are those that “issue from central behavioral capacities,” and so are “coordinated” or “unified,” and therefore count as actions. In contrast, those processes and behaviors not controlled by the central nervous system would be behaviors that do not issue from central capacities, would not be, properly speaking, coordinated, and so would not count as actions (p. 333).<sup>18</sup> This proposal for how to think of agency in organisms like us has some immediate plausibility. Our central nervous system does produce, control, and coordinate behavior like eating, swimming, etc.

Here, though, an obvious difficulty arises. It is not self-evident what the analogous point is supposed to be between larger animals whose actions are controlled by a central

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<sup>17</sup> This is important, as it is not obvious that this sort of behavior, in these organisms, should count as action. In point of fact, it is the very issue that is in dispute—that he is accusing others, especially those who “hyper-intellectualize” agency, of missing.

<sup>18</sup> We can add caveats about typically, roughly, etc. if we wish. But it does not make much difference—some sorting of action from mere behavior has to occur, and, as we will see, there is no sorting that can be done on the basis of this criterion.

nervous system and those organisms like paramecia and amoebae that do not have a central nervous system to control or coordinate behavior like swimming, eating, etc. However, given Burge's emphasis on a physiologically central controller and unifier of behavior in the source of the analogy (larger animals), it would be reasonable to look for such a physiologically central controller and unifier of behavior in the target of the analogy (single-celled organisms like amoebae and paramecia).

## **2.5. Issuing from central behavioral capacities understood as behavior produced or unified by a physiological element of an organism part one—the nucleus**

Indeed, there is an obvious candidate for a physiologically central controller or coordinator of behavior in single-celled, eukaryotic organisms that is roughly analogous to the central nervous system. The nucleus of single-celled organisms is very much its control center just like our central nervous system is for us. However, if the analogy between organisms with central nervous systems and single-celled organisms can be interpreted as implying that the central processes of eukaryotic organisms are those controlled by the nucleus (and the central processes are those that determine which processes count actions as distinct from mere behavior), then a substantial problem arises.

The problem is that the nucleus in single-celled organisms is involved in regulating, via gene expression, virtually every process of the cell, not just those like swimming, eating, and so on that Burge would identify as actions.<sup>19</sup> So, if behaviors controlled by the nucleus are the ones to count as actions, so long as there are behaviors that aren't supposed to count as actions in single-celled organisms, then all behaviors, including those that should not, will count as actions. Therefore, on the most straightforward interpretation of Burge's "analogical point," all behaviors are actions in single-celled organisms. Moreover, since Burge begins with the position that all actions are behaviors, the classes are identical. This is trouble for Burge's account because he wants a line, even if it is a fuzzy line, between actions and passive behaviors (mere behaviors). Identifying the behaviors controlled by the nucleus as those that constitute action makes

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<sup>19</sup> "Gene Expression | Learn Science at Scitable," n.d.; McAdams, Srinivasan, & Arkin, 2004; Seshasayee, Bertone, Fraser, & Luscombe, 2006; Wittkopp, 2007.

any such boundary impossible to establish because there will be no behaviors that are not also actions.

However, one could point out that even if we grant this, there would still be a division between actions (which would be the same kinds of things as behaviors) and the processes that are not even behavior (and therefore not actions). So, there would, at least, be actions and non-actions to be found amongst the processes of these organisms (even though all of the non-actions would be non-behaviors). This move may be available, but this matter is not as clear-cut as it might first seem.

In the first place, this is not what Burge wants in his account. He wants action to be a proper subset of behavior. In the second place, issuing from central capacities involves the coordinating of various parts and capacities of organisms (behavior is not coordinated otherwise); it would be odd to say that the coordinated products of the central capacities are not behaviors. This is because it would be odd to say that the processes of an organism are coordinated by, but not attributable to, the whole organism. Consequently, if the fact that a process issues from central capacities also confers the status of behavior, then virtually every process of those organisms would be both behavior and action. This would make the categories of action, behavior, and cellular processes identical. Action, therefore, would not pick out a distinct set of behaviors or a distinct subset of cellular processes.

The bleeding of the category of action to that of every cellular process might be prevented if one were willing to take on board some awkwardness. One could insist that, on Burge's view, there are various processes such as ion transport through a membrane that cannot be imputed to the whole organism or individual, and so are not behaviors.<sup>20</sup> So, even though such processes may be controlled by the nucleus, they are not behaviors; because actions are behaviors, such processes cannot be actions. Therefore, a distinction between actions and non-actions in single-celled organisms can be preserved, even though it sounds odd for non-action processes to have the property that

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<sup>20</sup> Forms of passive transport, like osmosis, do not require any energy expenditure on the part of the cell, and so depend upon the structural properties of the cellular membrane and wall to permit various ions through. The ions will still pass through the membrane and "balance" out with the surrounding environment even if the cell is dead. It would be odd to count processes that occur while an organism is dead among its behaviors.

makes a behavior an action. However, even if this argument works, it does not solve the problem that if actions are behavior “controlled by the nucleus,” then all behaviors are actions.

### **2.5.1. “Direct” control as opposed to “regulation” as identifying central behavioral capacities in single-celled organisms**

A person sympathetic to Burge might reasonably reply to the criticisms in Section 2.2 that understanding control in terms of mere regulation, as I have done so far, provides a very weak and minimal interpretation of “control.” So, to better interpret the analogy between actions as behaviors controlled by the central nervous system in larger animals and what underpins the distinction between action and mere behavior in single-celled organisms, we should look for physiological elements in single-celled organisms that have direct or immediate control over the production of archetypal instances of action. In other words, we should therefore look at the archetypal cases of action and see whether we can identify a common direct controller or producer of swimming, eating, mating, etc. in single-celled organisms.

This move has some traction. The nucleus, in most single-celled organisms—or the micronucleus in the case of some organisms like the paramecium—is the primary producer and regulator of reproduction by cell division. So, if reproduction by cell division is an action exemplar (I assume it is, since it is the single-celled analog of mating), we have a case of an action exemplar produced by the nucleus. However, we can easily think of the nucleus as not in “direct” control of many of Burge’s archetypal examples of action, like those cases of swimming, “navigating” while swimming, and eating (single-celled organisms don’t really parent). For example, the light-directed turning and swimming of many algae<sup>21</sup> is primarily controlled by the sensory machinery of the cell membrane and associated electrochemical gates in the cell membrane and wall. When stimulated, the sensors set off a chain of reactions that allows various positively charged ions into the cell body, where the resulting increase in concentration of these ions causes the cell’s propulsive appendages to change their beating pattern and thereby

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<sup>21</sup> We will encounter such algae again in detail—particularly *Chlamydomonas reinhardtii*—in Chapter 4.

change the direction the cell is swimming (relative to the inciting stimulus).<sup>22</sup> Indeed, in general, the sensory-guided swimming (and other types of propulsive movement) of single-celled eukaryotes functions this way. Though, in organisms like paramecia and amoebae that do not have rigid cell walls like algae, the cytoskeleton<sup>23</sup> plays a substantive role in altering the shape of the cell, helping it to change direction.<sup>24</sup> Moreover, in paramecia, eating functions via similar mechanisms to its swimming—ciliary beating and cytoskeletal movement create water flow over the surface of the cell that drives foodstuffs encountered while swimming into the oral groove and through there to the mouth of the cell where it will make its way to the gullet. (Paramecia are filter feeders that are, more or less, continuously eating.)<sup>25 26</sup>

It is evident, I think, that the nucleus cannot play the role of the common “direct” producer and controller of actions as opposed to peripheral processes akin to the role that might be played by the central nervous system in organisms like us. This is because if we did identify the nucleus as playing this role, we would either have to 1) grant that every behavior of the cell, and possibly the processes that are not even behaviors according to Burge, will count as action (see Section 2.5), or 2) we have to discount many of the archetypal examples of action like swimming because they are not “directly”

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<sup>22</sup> See, for example, Hegemann, 2008; Hegemann & Berthold, 2009; Sineshchekov, Jung, & Spudich, 2002.

<sup>23</sup> The cytoskeleton is basically an interconnected mass of filaments and tubules that give the cell structure, regulate a number of processes within the cell, move organelles, etc. around within the cell, and by contraction and expansion, as well as attachment and detachment from various parts of the cell membrane, alter the cell’s shape. (The cytoskeleton plays a much smaller role in algae because of the rigid cell wall that gives those cells their structure and resistance to environmentally caused deformation.)

<sup>24</sup> Amoebae, unlike paramecia and algae, do not rely primarily upon the beating of cilia or flagella (hair-like structures that “whip” back and forth—cilia are shorter and are plentifully distributed over the cell’s surface, while flagella are longer and usually come in pairs) for locomotion. Rather, they rely upon pseudopods—extensions of the cell membrane looking at times like tentacles or bulbous “lumps”—to move around via a kind of “walking.”

<sup>25</sup> See Dembo, 1989; Gebauer, Watzke, & Machemer, 1999; Hegemann, 2008; Jung, Guevorkian, & Valles, 2014; Lodish et al., 2000; Verni & Gualtieri, 1997.

<sup>26</sup> The nucleus is, of course, involved in various regulations of internal processes that will affect the responsiveness of the cells to stimuli. Indeed, the circadian rhythm of the light-guided algae will strongly inhibit light-directed movement at nighttime, even if artificial light is introduced (Hegemann, 2008; Mittag, Kiaulehn, & Johnson, 2005; Oldenhof, Zachleder, & Van Den Ende, 2006). But the nucleus does not organize or unify this behavior “on the fly” as we tend to think the CNS would in the case of our own swimming.

controlled by the nucleus. Neither option will enable a unified account of the difference between action and mere behavior of the sort Burge intends to construct.

Moreover, if one wanted to solve this problem by saying that we should look instead to the cytoskeleton or the cell membrane as the right physiological producer and controller of the archetypal examples of action, the same basic problems emerge. These elements of a cell could each be plausibly identified as the “direct” controller of behavior like swimming, eating, etc. However, the cytoskeleton and the cell membrane would also fail to “directly” control reproduction by cell division, so they would, like the nucleus, fail to cover key exemplars of action. Furthermore, as is the case with the nucleus, they would also control a large number of processes and behaviors that Burge would not count as actions, such as digestion, the regulation of various material’s passage into and out of the cell, protein transfer, and synthesis, etc.<sup>27</sup>

The important general lesson to be drawn from this discussion is that the control of behavior in single-celled organisms is diffuse. For many of Burge’s key exemplars of action (and for “mere behaviors” like digestion too), there are many loci of behavioral control across many different elements of the organism at a given time.<sup>28</sup> It is, therefore, unlikely that any single physiological element of the cell could effectively divide action from mere behavior as Burge thinks the central nervous system does in cases like ours. To my mind, these results cast serious doubt on any prospects for coherently spelling out the “analogical point” that would enable a distinction between action and mere behavior for organisms with and without central nervous systems. At a minimum, this is

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<sup>27</sup> Burge does not state that there *must* be a singular controller—that actions have to be controlled by the same systems or physiological components. So, this argument does not entirely succeed against an interpretation of Burge’s account as holding that there must be *some* form of centralization, unification, and integration for a behavior to be an action. There are three things I can say against this though. The first is that when Burge does identify in clear, biologically grounded terms what the central behaviors are, he explicitly notes a single physiological component or system that all actions are controlled by and all behaviors are not. The second is that, if this is not what Burge means, it is unclear what it is these exemplars have in common in terms of the production of their behavior, and what will distinguish them, as a group, from behavior more generally. If an appeal is made to coordination more generally, or to integration generally, and so on, then all behavior, again, counts as action—certainly various forms of cellular regulation, like the circadian rhythm, digestion, etc., would.

<sup>28</sup> Gene expression is itself regulated and influenced by the current state of the various parts of the cell like the presence of various chemicals, the current state of decay of previously constructed regulatory proteins, etc.

the situation without more guidance from Burge on how this “analogical point” should be understood.

## **2.6. Issuing from central behavioral capacities understood as behavior produced by or unified by a physiological element of an organism part two—the central nervous system**

Prospects for something analogous separating action from mere behavior in organisms with and without central nervous systems grow even poorer once we realize that there are deep problems with the source of this analogy similar to those just outlined for the target of the analogy. Recall that in larger animals, Burge identifies the behaviors that issue from central behavioral capacities as those that are controlled by the central nervous system. The trouble is that the central nervous system controls, to some degree, virtually every process of the organisms that have them.<sup>29</sup> So, as in the case of single-celled organisms and their nuclei, it is unlikely that there would be any process that Burge would judge to be a “passive” (or mere) behavior that would not also count as action for larger animals with central nervous systems.

This difficulty can be demonstrated using Burge’s own examples of “passive behavior” that should not count as actions. Shivering, coughing, and sneezing (p. 332) are controlled by various brain areas. Those most centrally involved in shivering are the pre-optic area in the hypothalamus for initiating the process, and inhibitory neurons in the dorsomedial hypothalamus to shut the process off (Nakamura & Morrison 2011). Similar points hold for behavior like coughing, the control of which is found in the brain stem and pons (Polverino et al., 2012), and sneezing, which is primarily located in the medulla (Fink, 2001; Nonaka, Unno, Ohta, & Mori, 1990; Seijo-Martínez, Varela-Freijanes, Grandes, & Vázquez, 2006). This would likely also follow for Schreck reactions, like when a deer is frozen by headlights or by fear of a predator. Such reactions would appear to require the engagement of sensory and perceptual processes that would involve the brain to prompt the response (p. 332), and the motor commands that produce the rigid posture also likely originate in the brain. Moreover, the central nervous system

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<sup>29</sup> See Kandel, 2013.



will also control virtually every process that Burge would (or could) count as behavior but not as action—e.g., breathing, sweating, swallowing, and so on<sup>30</sup> (see Kandel, 2013). This means that virtually every member of the class of behavior will be an action. So, straightforwardly, Burge’s proposal for a physiologically grounded understanding of “issuing from central capacities” cannot distinguish action as a special sub-category of behavior.

In addition, the identification of actions with those “processes controlled by the central nervous system” in organisms like us creates an awkwardness regarding processes and events that do not even count as behavior for Burge, like those that arose in the case of single-celled organisms (see Section 2.5). The central nervous system controls a great number of processes that are not supposed to count as behavior on Burge’s view—growth, maturation (p. 331), eye saccades, “sensory states that regulate muscle tone,” vascular constrictions (p. 372), and products of the “classic reflex arc” (p. 333).<sup>31</sup> Since “issuing from central capacities” is roughly equivalent to “coordinated by/with central capacities,” it would be odd if there were centrally coordinated processes that were not attributable to the whole organism (and so would not count as behavior). So, it may be reasonable to count reflexes, and any other process controlled by the central nervous system, as behaviors that issue from central capacities.<sup>32</sup> Therefore, the possibility emerges (parallel to that seen in single-celled organisms, see Section 2.5) that the classes of actions, behavior, and processes produced by some part of the animal are identical. (At a minimum though, we get an expansion of the category of “mere behaviors” that should not count as actions but do.)

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<sup>30</sup> This is basically the same argument as was deployed for the nucleus above (see Section 2.5). There is an analogy that holds between organisms with central nervous systems and those without, but I do not believe it is one Burge would want.

<sup>31</sup> See Kandel, 2013.

<sup>32</sup> The reflexes Burge discusses are often called “reflex actions” and are typically thought of as behavior. See Carter, Crago, & Keith, 1990; Dietz, 1993; Ellaway & Trott, 1978; Fearing, 1931; Murata et al., 2014; Riddoch, 1917; Kandel, 2013. Indeed, I think many, if not all of them, could be counted as behavior on Burge’s view once they are examined in detail. They are functional and coordinated; multiple opposing muscle groups are typically involved in their execution, and they are typically functional. Stretch reflexes, for example, are “there to” correct and balance posture. And normally, I think, we believe whole animals correct their posture, and so attribute such adjustments to them.

Once again, as in the case of single-celled organisms, one could avoid the conclusion that virtually every process occurring within an organism with a central nervous system is an action by pointing out that Burge is clear that actions are a type of behavior, and he does not count reflexes etc. as behaviors. This solution is, however, still awkward. And it does not solve the primary problem of the category of action being identical to the category of behavior, rather than being a (more or less) distinct subset of behavior, for organisms with central nervous systems.

### **2.6.1. Some intermediary conclusions**

Burge is correct—there is an “analogical point” to be made about single-celled organisms consistent with the idea that, in larger animals, the processes that “issue from central behavioral capacities”—and are thereby actions—are those processes controlled by the central nervous system. In single-celled organisms, one can also physiologically identify a controller of behavior like mating (reproduction), swimming, and eating—the nucleus of the cell. However, in both cases, the identified physiological structures control or regulate virtually every process of the organism. This potentially entails that every process of a single-celled organism and every process of a larger animal will “issue from central behavioral capacities” and thereby count as an action. Further, at a minimum, this *does* entail that virtually every behavior of a larger animal or single-celled organism will also count as an action. This is a substantive problem because “issuing from central behavioral capacities” is the property that is to distinguish action from mere behavior. If this property cannot be clearly (biologically, physiologically, etc.) interpreted in a manner that produces this separation, Burge does not have non-representational grounds to underwrite the division between his own exemplars of action and his exemplars of mere behavior.

## **2.7. Making the explicit characterization of central behavioral capacities consistent with Burge’s exemplars of action and behavior and non-behavioral processes**

However, one might recall that Burge holds that his account of Primitive Agency will be “driven by examples” (p. 331). In line with this then, perhaps what we should do is take the exemplars for granted and adjust Burge’s explicit cashing out of “behaviors issuing

from central capacities” as “behaviors controlled by the central nervous system” in order to cohere with the exemplars, rather than adjusting the exemplars to fit the characterization (which is, effectively, what I have done in the preceding sections discussing the complications for his view). If this approach is taken, we might then have a physiologically or biologically grounded account of action that coheres with the exemplars of action and mere behavior (and non-behavioral processes). Indeed, I think such an adjustment will align Burge’s characterization of action with his exemplars. The difficulty is that making these adjustments will collapse Burge’s position into a representational account of agency instead of a non-representational account of agency, which is what he wants to develop.

### **2.7.1. Using the exemplars to determine the identity of the “central capacities,” or Making Burge’s explicit characterization of central behavioral capacities and his examples consistent results in a representational account of agency**

The first adjustment that can easily be made is in the case of non-behavioral processes like those of the classic reflex arc, like stretch reflexes.<sup>33</sup> The spine is directly involved in their production, but the brain plays almost no role. Moreover, significant sequenced, adaptive responses to the environment seem to rely heavily on the brain for guidance and not the spinal cord on its own<sup>34</sup>. Consequently, perhaps we should think that behaviors produced and controlled by the brain constitute those that “issue from central capacities,” rather than merely those that are controlled by the central nervous system (which is comprised of the brain and the spinal cord).<sup>35</sup> This adjustment will not quite work, however, because behaviors like coughing and shivering are controlled by parts of the brain like the hypothalamus and brainstem (see Section 2.6). But given that these and similar components of the brain coordinate quite simple, truncated, reflexive, and involuntary responses and are not responsible for initiating more substantive,

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<sup>33</sup> Once more, Burge does not cite any literature in this case. Stretch reflexes, Golgi reflexes, and flexor reflexes involve at least the spine (Chalmers, 2004; Kandel, 2013; Kitano & Kocejka, 2009; Knierim, n.d.; Masugi, Obata, Inoue, Kawashima, & Nakazawa, 2017).

<sup>34</sup> Our walking gate can be elicited from the spine alone, but walking around the world as we commonly do will not be achieved by spinal control of our gate alone (Minassian, Hofstoetter, Dzeladini, Guertin, & Ijspeert, 2017).

<sup>35</sup> This move readily avoids the awkwardness that reflexes present for the raw controlled-by-the-central-nervous-system formulation.

coordinated behavior (despite their involvement in the production and regulation of more sophisticated behavior), the behaviors that issue from “just” these components of the brain should also probably not count as issuing from central capacities either.

At this point, it becomes evident that the parts of the central nervous system left to play the role of producer and controller of the exemplar active behaviors like swimming, navigating, eating, mating, etc. are the hemispheres of the cerebrum.<sup>36</sup> The hemispheres, though, are where most of what would typically be considered the representation-dependent work of the brain occurs—visual processing, auditory processing, haptic processing, motor processing, and the generation of motor programs. Moreover, the behaviors Burge identifies as exemplars of action—like swimming, eating, navigating, mating, and parenting—typically depend upon the activation of motor commands in the motor cortexes and involve perceptual processing for their initiation and control. So, it appears that the archetypal cases of action in larger animals will typically depend upon these representational brain states and processes to produce and coordinate such behavior. Further, if the swimming, navigating, eating, or parenting is at all complex, it will likely require the involvement of the pre-frontal cortices where planning is thought to occur, and will also heavily involve representational states.<sup>37</sup>

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<sup>36</sup> Though the cerebrum also includes the cerebellum, the hypothalamus, and the thalamus, given the “primary” role such brain structures play in producing behaviors like shivering etc., which are “passive behaviors,” we should likely restrict “issuing from central behavioral capabilities” to behavior controlled by the hemispheres.

<sup>37</sup> One might push back on this line of argument and point out that this point would only apply to mammals, and that animals without a prefrontal cortex or large brain (like spiders and reptiles) engage in things like navigation and parenting. So, Burge is not tied to this line of reasoning regarding a hidden dependence upon representation for action. There are a few things to say to this. The first is that when trying to illustrate the division between central and peripheral processes, Burge likely has in mind mammalian nervous systems because of the examples he uses of non-behavior-like shivering, coughing, sneezing, etc., which are readily familiar from our own experience and our experience of other mammalian behavior. Moreover, he states that he is looking at the difference within “large animals” of behavioral generation and control of actions and mere behaviors, and most of the large animals we would be familiar with are mammals. So, if such organisms are the source of his examples, the anatomical and physiological divisions within such animals are the ones we should be looking at to evaluate his claims regarding this division so that we can see if they work out as he would like in at least this case. Second, the situation gets worse for him once we start bringing back into the discussion reptiles, arachnids, insects, and so on because their nervous systems and brains are less complex than mammals. Consider the visual systems of monkeys and turtles, for example (Naumann et al., 2015). The simpler nervous systems of non-mammals will be much less anatomically and physiologically distinct with respect to the generation of the behavior Burge identifies as active and that which he identifies as passive. So, there will be even less support for any kind of physiological distinction between the

The problem here should be apparent. If we adjust Burge's physiological description of "issuing from central behavioral capacities" to be consistent with his "driving" exemplars of action and mere behavior, Burge is left with a representational account of agency that will likely only apply to large animals with central nervous systems like ours. It would appear that single-celled organisms and any other organism will lack the requisite neurological-representational states and so cannot produce actions, only behavior.

Someone who believes Burge is on to something here might insist that there could still be some "analogical point" to be made for single-celled organisms on the basis of the representational agency found in larger animals. However, this insistence would be difficult to sustain; it is entirely unclear what that analogical point would be. Moreover, given the diffuse nature of behavioral control in eukaryotic single-celled organisms (see Section 2.5), it is unlikely that any representation-like properties one might identify as being involved in the production of swimming, eating, etc. would be able to maintain a distinction between action and mere behavior. Whatever properties one might identify as the analogue of our representational "central behavioral capacities" would almost certainly also be involved in controlling behavior that is not action (as well as processes that are not even behavior).<sup>38</sup> The consequence of this is that the account of agency Burge offers can only divide action from mere behavior in organisms that use representations to generate their actions, and is limited to those cases.<sup>39</sup>

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generation of behaviors that aren't actions—like shivers and so on—and those like navigating, parenting, and so on that Burge suggests exist in "large animals." Third, perception is representational for Burge. So, even if a small-brained animal does not have a prefrontal cortex, etc., it will still likely use representational states—perceptual states—to guide its navigating, mating, and so on.

<sup>38</sup> Familiar concerns, therefore, re-emerge regarding whether action can be distinguished meaningfully from the category of "cellular processes" (see Section 2.5).

<sup>39</sup> If this line is mostly correct, one could make the move to try compromise on Burge's position and instead try to limit Primitive Agency to the "lowest" representational agency to be found in nature. Burge does believe that there are more and less sophisticated kinds of psychological or representational agency. There would be the more basic kind that is guided by perception and its representational contents, and then there would be intentional agency of the kind we are familiar with from our own experience, which depends upon representational mental states like beliefs, desires, and intentions. However, this concession would not be desirable. Burge wants to ground the emergence and development of perception in a non-representational Primitive Agency. Moving to a perceptual Primitive Agency ultimately frustrates these ends. Further, if it did turn out that Burge was willing to move to a "primitive representational (perceptual) agency" over his non-representational Primitive Agency as it is presented in his book, conditions would still have to be set out to distinguish action and mere behavior. Perception is involved in the production of "mere

### 2.7.2. Some summing up of results so far

“Issuing from central behavioral capacities” is the key property that will distinguish action from mere behavior in Burge’s account of Primitive Agency. However, a straightforward physiological interpretation of Burge’s identification of “issuing from central capacities” with “central nervous system control” in larger animals cannot separate the categories of mere behavior and action in non-representational terms for either larger animals or single-celled organisms. Moreover, adjustments of this explicit characterization of “issuing from central behavioral capacities” to align with Burge’s exemplars of action, mere behavior, and non-behavioral processes reveals only a representational account of agency that is limited to larger organisms with nervous systems like ours.

In light of the fact that a non-representationalist interpretation of “issuing from central behavioral capacities” is, at least so far, empirically uninterpretable, and given that a representational interpretation is unacceptable, Burge’s account offers only a very murky picture of what underpins the distinction between action and mere behavior.

Consequently, Burge’s account only concretely offers one part of the account of Primitive Agency that is proposed. We have a list of proposed archetypal examples that are purported to be based on judgments that we have about which behaviors are “inherently active” (actions)<sup>40</sup> to go along with the commitment to the existence of some property or set of properties—whatever “central capacities” are—that underpin their status as actions. The account, at most, tells us which behaviors are supposed to be actions and which are not, but it does not tell us why some behaviors are actions and others are not. This does not make for a compelling account of Primitive Agency.

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behavior” as well. Finding one’s self paralyzed by fear of a predator, as in a “Schreck reaction” is a non-active behavior for Burge, but may well depend upon perception, and therefore representations, of the predator causing the fear and paralysis.

<sup>40</sup> Burge claims that “we” make such judgments. This is an empirical claim about the judgments human beings actually make regarding the behavior of organisms. Burge produces no empirical evidence beyond his own usage of “action,” “agent,” and other cognates. Moreover, as we will see toward the end of the chapter, there is empirical evidence to support the view that we do not judge certain types of behavior to be inherently active in our intuitive attributions of agency (see Section 2.8.2).

## **2.8. Addressing the potential charge of offering an uncharitable assessment of Burge's account of Primitive Agency**

Someone sympathetic to Burge's perspective on action might think that these conclusions are uncharitable, or at least too strong, and point out that Burge does say:

I doubt that there is an independent criterion for whole-individual agency. Again, the fact that the amoeba is eating seems to carry as much weight in the judgment that the eating is active rather than passive behavior as the fact that there is coordination with the individual's central capabilities. Anatomy and physiology can sometimes guide what counts as a central capability, but not always. As I indicated earlier, I think that our understanding of these matters is probably partly guided by an antecedent list of whole individual functions that already embody conceptions of activity by the whole, individual organism—eating, navigating, mating, and so on (p. 334).

Here Burge indicates that anatomy and physiology will not always be guides for distinguishing central capacities from peripheral ones (and so action from mere behavior), and appears to place more weight on the exemplars of behavior we judge to be inherently active (and those we judge not to be) than on any explicit biological cashing out of the properties that are supposed to underpin the distinction between the exemplars of action and mere behavior. The account, we might say, is not merely “example driven,” but something more like “example dominated” or “example dictated.”

Therefore, someone sympathetic to Burge's ideas about agency and his philosophical orientation generally might here claim that I have been too focused on how central capacities need to be spelled out to enable the sorting of exemplars. So, in doing this, I have illegitimately downplayed the fundamental importance of exemplars in his account of agency—i.e., downplayed how much theoretical content or guidance is provided by the exemplars. Moreover, one might go on to claim that I have also neglected how Burge's account of Primitive Agency fits into his broader ideas about the development of our understanding and application of concepts over time.

So, continues this line of thought, it is not fatal to his view that there is no available plausible interpretation of his remarks regarding the biological underpinning of a non-representational distinction between action and mere behavior—there is almost certainly

something that does.<sup>41</sup> So, even though Burge has not gotten right and has not entirely spelled out what does underpin the distinction, he has gestured toward it, and has provided paradigmatic cases of action to further point the way toward those properties. Additionally, we typically think that theoretical consistency is a virtue, so the fact that the account of Primitive Agency is consistent with Burge's broader view of conceptual development provides the view with more resilience than it would have if it stood entirely independently. Therefore, once we realize all of this, we should also realize that Burge's account of Primitive Agency can—and should—be retained, despite its present empirical shortcomings. One might add that Burge's view may not be compelling, perhaps, but it is *plausible and promising*.

However, this line of defense will not hold up under scrutiny. Even if we accept Burge's framework for conceptual development, this line of thought makes his view of action one that cannot be rejected on any empirical grounds, and therefore renders it trivially compatible with any worked-out account of agency, even views Burge would want to reject. In order to explicate the mechanics of this defense and why it will not aid Burge's account of Primitive Agency, I will first need to describe Burge's perspective on concept development.

### **2.8.1. Burge on concept development**

In broad outline, Burge holds that developing a robust sense of a concept's proper extension will begin with a set of prototypical exemplars that we believe instantiate the concept. With the exemplars in hand, we go on to formulate explicit criteria ("norms" in Burge's terms) regarding which examples should count as actual instances of the concept and which should not. The development of these criteria is the product of what amounts to a conversation (Burge, 1986).<sup>42,43</sup> Such conversations are not supposed to

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<sup>41</sup> It could also be added that I have not ruled out every possible interpretation of Burge's remarks about the nature of "issuing from central capacities"—so, I have not shown that there are *no* interpretations of central behavioral capacities that will work out.

<sup>42</sup> This is, of course, an "ur-story" regarding our developing an account of the proper extension of a concept, or our determining the proper extension of a concept. We do not (or at least very rarely) do our work on the proper extension of concepts from a theoretically innocent position.

<sup>43</sup> Possessing the concept and using the concept is, for Burge, evidence that there is a phenomenon in the world that our concept "latches" on to, no matter how poor we may be at applying the concept to the correct examples. This, of course, will not hold for every concept—



be free-for-alls and so operate under two constraints that keep the conversation pointed at discovering the genuine extensions of a concept. The first is the world—those things that actually do or do not instantiate (“fall under”) the concept discussed. The second constraint on the discourse is the role played by experts—those who can make a persuasive case by providing reasons (related to the way things actually are in the world)<sup>44</sup> as to what should and should not be counted as an instance of the concept under discussion. The opinions of experts, therefore, carry more weight; they are privileged in this conversation relative to the opinions of non-experts.

As these appropriately constrained conversations progress, it may turn out that many or even most of our initial exemplars of a concept’s extension were not true instances of the concept. It may also turn out that our initial core exemplars are instances of the concept, but that we missed a number of genuine instances of the concept’s extension when we began. However, it is important to note that one does not need to be an expert or be able to spell out the criteria (norms) that govern the proper application of a concept in order to apply the concept correctly. One can be good at identifying instantiations of a concept without knowing why the identified instantiation falls under that concept. Further, one’s application might even be a bit hazy and inaccurate, but so long as one deploys it in broad accordance with the norms governing its extension, then one is in possession of the concept in question. Indeed, this fact allows us to latch on to a concept’s extension and begin the conversation to determine the norms of extension despite a potentially poor initial grasp of the concept’s proper instantiations.

The defense of Burge’s account of Primitive Agency appealing to this understanding of conceptual development would claim that Burge has offered the prototypical examples with which we are to start an account of a type of thing in the world, i.e., determining the norms that govern the concept’s proper application. Given that there is almost certainly an actual thing in the world—agency—that we have grasped on to (even if the grasping is loose or amounts only to laying our hand over the object sought), Burge has offered a

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some of them, like unicorn or God, may have no extension. And then it is likely our task to sort out just what “out there” in the world led us to have these concepts that do not “latch on” to any really existing entities in the world.

<sup>44</sup> Therefore, there is an objective set of norms that exists “out there” that determines the correct application of a concept, whether or not we ever discover them in their entirety via this kind of conversation.

conception of agency that latches on to the real thing in the world (again, even if that latching is fuzzy or imprecise right now). There will be actions of some type like those examples he has offered, and there will be something in common with those actions—what Burge is pointing to with “central capacities”—that will make them actions (as opposed to mere behaviors). Moreover, Burge’s list of exemplars is one that we start with, and we can be presumed to be pretty good at reliably picking out actions and agents.<sup>45</sup> (Insert your own just-so story for why we would have evolved such reliable judgments of which things are agents and which are not.) Therefore, Burge’s account, as a set of archetypal examples of actions and a suggestion about what renders these behaviors actions, is pointing us in the right direction for discovering a more fleshed-out account of Primitive Agency (or Biologically Basic Agency, as I call it). So, even though Burge has not offered a full account of agency or an account that is easy to interpret, he has provided the essential material for sorting out the nature of agency. And therefore, his account can—and should—be retained despite the fact that the norms Burge suggests are contradicted by the empirical findings, or when made compatible with them, fail to produce the desired non-representational account of agency.

### **2.8.2. The fact that Burge may be “on to something” will not help his account of Primitive Agency**

This isn’t an easily diffused argumentative move. Anyone who accepts that agency is a real thing to be found in the organic world and who shares the belief that agency likely extends into non-representational territory will be committed to the idea that there probably is some kind of non-representational agency that we can find that may well include some, most, or all of Burge’s exemplars.

However, this defense effectively renders Burge’s account of Primitive Agency, which is intended to be part of the empirical research on perception and animal behavior and, moreover, grounded in that research, impossible to reject on empirical grounds. His view can always be retained via this strategy no matter how the empirical facts turn out, because he is surely “on to something” that falls under the correct extensions of “action”

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<sup>45</sup> Again, Burge has not established that this is, in fact, how “we” human judges of agency apply the concept (see footnotes 28 and 37).

and “agency,”<sup>46</sup> whether the instantiations of those concepts ultimately line up well with Burge’s exemplars and proposed biological grounding or not. However, while this may make the view virtually impossible to depose, we typically do not think this is a good feature for an empirically oriented theory to have. Karl Popper (1959, 1963) famously developed a philosophy of science around the idea that this is a bad thing for a theory about the empirical world. Granted, Popper’s view is incomplete, and most readers would likely reject it, but we have held on to the idea that it is not good when a theory about the empirical world is immune to any contrary empirical findings (or a dearth of empirical support or coherence). We want views that rule out at least some empirical possibilities or are at least held to be highly suspect when they do not cohere with the empirical findings.<sup>47</sup>

Furthermore, this line of defense of Primitive Agency as being on to something despite being vague and likely incorrect (see Sections 2.4 to 2.6) with respect to what ultimately, biologically, ethologically, etc. underpins agency in organisms lacking representational capacities effectively renders Burge’s account trivial. Indeed, two incompatible pictures of agency and action could absorb and explain, or explain away, Burge’s exemplars while identifying the “central capacities” that determine which behaviors are actions and why. Even worse, these two accounts each reject one of Burge’s two explicitly stated goals for an account of Primitive Agency—that the account be non-representational, and that action is a special subclass of the behavior found in organisms.

In the first instance, the “hyper-intellectualized” view of agency that Burge is most interested in rejecting could readily absorb his examples and give a ready interpretation of “central capacities.” Because Burge’s view of conceptual development grants that our initial prototypical examples (or our examples at any point in the discourse, really) could fail to be real examples along various dimensions or could be inaccurate in many ways, the representationalist view of agency could simply grant that yes, eating, swimming, navigating, mating, child rearing, etc. are all examples of actions, but they are only “real”

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<sup>46</sup> I would say, personally, that Burge has merely identified the minimum commitments of any program with similar aims. Though, I also accept that agency, Biologically Basic or otherwise, may not actually be a coherent “natural kind” of any sort. It might turn out that any such concept is untenable.

<sup>47</sup> The only position Burge’s account would possibly rule out under this rubric would be the non-existence of agency. But this is not necessarily a virtue. It is possible that agency is not a “real” category of the world.

examples in cases where they can be explained by the appropriate representational states—beliefs, desires, etc.<sup>48</sup> Continuing this line of thought is easy: We naturally, but erroneously, extend assessments of agency to organisms that exhibit behavior similar to our own in the absence of such representations. In explaining away the non-representational cases, one might make some appeal to the human tendency to anthropomorphize virtually anything and everything we find in the world as evidence for the plausibility of this take. So, it might appear that we think that these are inherently active behaviors, and we might even have that idea in our minds, but we are simply applying the concept sloppily or are confused by these superficial behavioral similarities when compared with the experts in the matter.

In the second instance, some empirical work into the human tendency to attribute agency to virtually any moving object in the world could provide us with a theory of action that would extend agency far beyond the bounds Burge would (initially) find acceptable, but would also absorb Burge's archetypal examples of action. This research has found that our intuitive applications of agency to objects in the world is not limited to "inherently active" behavioral kinds like swimming, eating, etc. found among organisms. Rather, it seems that we will judge moving images projected on a computer screen as agents, and we will attribute agency to objects as diverse as the wind, the sun, the moon, the ocean, the sky, etc. Our propensity to make these judgments appears to depend upon an assessment of the degree to which the observed motion is perceived to be causally independent of us (and other forces) (Barrett, 2004; Barrett & Johnson, 2003; Guthrie, 1993; Heider & Simmel, 1944).<sup>49</sup>

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<sup>48</sup> This would cohere neatly with the fact that only a representational interpretation of Burge's explicit biological characterization of "central behavioral capacities" can divide his exemplars "correctly."

<sup>49</sup> If these findings about our intuitive attributions of agency are even remotely accurate, the idea that we come to discussions with an antecedent list of behaviors we judge to be inherently active—like swimming, eating, etc.—is called into question as an accurate characterization of how human beings divide action and not-action. One pillar of support Burge appears to want for his examples is that "we"—human beings—generally make these judgments, because that is indirect evidence of the reliability of these purported judgments, and so would follow the point that Burge has caught on to a real distinction between action and behavior. But if we do not judge, generally or substantively, as Burge describes, then Burge does not have this indirect evidence that he is on to the right division of action from mere behavior. Moreover, if we are found to be unreliable in our attributions of agency—we attribute agency to things, that upon even modest reflection, we would not count as agents—our intuitive judgments about agency are no longer

On the theory derived from these findings, actions would be those events where objects move causally independently of other objects, forces, and us. (Enabling causally independent movement would be the property held in common across all instances of “central behavioral capacities.”) So, as was the case with the “hyper-intellectualized” view of agency, Burge’s examples can be relatively straightforwardly absorbed. Swimming, eating, navigating, etc. in single-celled organisms would be instances of behaviors that are causally independent from us and other entities, and therefore actions. But, of course, agency would not be limited to these exemplars, or even to a list of behavioral types exhibited by animals and single-celled organisms. The concept would properly apply to objects that are not organisms—possibly atoms or electrons, and would likely include plants as agents, which Burge explicitly rejects as candidates for agency<sup>50</sup> (p. 331). (Somewhat ironically, this proposal might do a better job of sorting Burge’s own examples as he wants them sorted—coughing, sneezing, and shivering have a readily identified external causal component that might easily lead us not to attribute agency to these behaviors.)

### **2.8.3. A brief summary**

If we accept that we can hold on to Burge’s conception of Primitive Agency because there is something out there that his account has latched on to and so can be retained no matter how inconsistent it appears to be with the empirical findings regarding organic behavior, Burge’s view still faces two deep problems. The first is that it will fail to play by the rules we typically think an empirical or empirically informed theory of anything should play by. Such theories should be susceptible to rejection or at least to tentative abandonment if they are contradicted by or are inconsistent with the relevant empirical findings. The second problem is that this strategy renders Burge’s account trivial because all of its elements are negotiable, and therefore it can be absorbed by any

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even indirect evidence of a “real” distinction in the world. So, even if a substantive number of people do judge matters as Burge describes, we have little reason to take those judgments as providing much evidence of those judgments being reliable (see footnotes 24 and 29). So, while I think this matter creates problems for Burge’s view, the line of argument I am currently running in the main text grants that we are, at least, roughly reliable in our attributions of action and agency. Even if we are roughly reliable, our judgments can still be absorbed by the “hyper-intellectualized” view and the “causal independence” view.

<sup>50</sup> This is because plants are “usually not construed as exhibiting behavior” (p. 333), and actions are a type of behavior. Something like a Venus flytrap might, but typically, for Burge, plants do not behave (see footnote 2).

competitor view, even one that would reject some of Burge's initial commitments for an account of Primitive Agency such as non-representationality or limiting agency to animals and certain animal-like single-celled organisms.

## **2.9. Conclusions**

Tyler Burge's (2009, 2010) account of Primitive Agency aims to provide a biologically, ethologically, or zoologically grounded non-representational account of agency that distinguishes the category of action from that of mere behavior—and thereby establish the class of actions as a proper subset of the class of behavior. This account is to be guided by a set of archetypal exemplars of action and mere behavior as well as a characterization of the properties that, when instantiated by a behavior, render that behavior an action. However, all straightforward biologically grounded interpretations of Burge's remarks concerning the properties that underpin the distinction between action and mere behavior cannot sustain a non-representational account of the distinction. Moreover, the only biologically grounded interpretation where this distinction can be maintained results in a representational account of agency that is limited to larger animals that possess central nervous systems.

Since a representational account is undesirable in this case, the matter of what makes a behavior an action is left unclear, and given the lack of empirical support, might lead one to reject the view. However, one sympathetic to Burge's account here as well as to his broader philosophical system could try to defend his account on his broader understanding of conceptual development. This defense doubles down on the fact that Burge has offered clear exemplars and a suggestion of what the distinction between action and mere behavior depends upon. The kernel of this defense is that Burge's account cannot be rejected because it is "on to something" that is really out there in the world, i.e., the actions and agents that exist in the world. This move, though, effectively removes any requirement that Burge's account be empirically evaluable and has the further consequence of rendering the view compatible with any competing view of agency that can account for the exemplars and give a plausible account of the properties that distinguish action from mere behavior.

Most importantly, however, this discussion of Burge's view allows for the development of a general—but necessary—constraint on any account of Biologically Basic Agency that

is to be grounded in or integrated with the biological, ethological, etc. findings regarding organic behavior. One's account should be answerable to the empirical findings—able to be rejected or at least discounted on empirical grounds. This will require making claims about the nature of agency that are of the type that can be checked against the relevant biological findings—these may be functional claims, evolutionary claims, or claims about mechanisms, niches, etc. Opting out of this constraint will very likely render one's account trivial, making it so adaptable to the empirical findings that one's account can be made consistent with or absorbed by any other account of agency, even those one wishes to reject. Straightforwardly, a trivial account of action ultimately offers no insight into the matter. Ideally, even if one is wrong about agency, one hopes to be wrong in a useful way.

### **2.9.1. Looking forward**

In the next two chapters, I turn to discussing Kim Sterelny's (2003) highly intuitive (and commonly held) view of the simplest type of agency to be found in nature from which our familiar representational agency evolved. This foundational kind of agency consists of the ability to produce a single, adaptive behavioral response in the presence of a single feature-type in the world, the release of which depends upon a single environmental signal or cue, and that this kind of behavioral system is present in many varieties of organisms in many different evolutionary lineages.

Chapter 3 addresses Sterelny's view and is concerned with establishing two points. The first is that despite initial appearances to the contrary, this sort of behavioral system is neither common nor typical of organic life on planet Earth. The second is that whatever picture of the foundational sort of agency to be found in nature, any story about the evolution of one widely and diversely instantiated general functional behavioral type to another is highly implausible. Chapter 4 takes on the task of showing that even if Sterelny's view were modified so that only very simple organisms instantiate the simplest sorts of behavioral systems—ones that produce environmental feature-specialized behavioral responses—the view still would not accurately capture how simple organisms behaviorally adapt to their environments. Rather, it turns out that the adaptive responses typical of simple organisms are organized in an entirely different way. Simple organisms adjust their orientation relative to a number of survival-relevant features of their environment at one time. This sort of behavior, which I dub "Utopic Behavior,"

establishes a potential candidate or baseline for Biologically Basic Agency (which will be evaluated in Chapter 5).



## Chapter 3.

### The Detection System: Part 1

#### 3.1. Introduction

In the previous chapter, I established that Tyler Burge's (2009, 2010) account of Primitive Agency—his version of what I am calling Biologically Basic Agency—is empirically “uncheckable.” It cannot be rejected on the basis of any empirical findings regarding organism behavior. Any issue with vagueness or inconsistency regarding the relevant empirical findings can be resisted because the concept of Primitive Agency can always be adjusted and reinterpreted. This is because agency is certainly a real feature of the world, and there is certainly *something*, biologically speaking, that underpins or instantiates this agency—and whatever that something is, this is what Burge's account is “pointing to.” However, while this feature effectively renders Burge's view of agency virtually impossible to refute, it also renders the view entirely trivial; the view can be rendered consistent with virtually any other theory of action and agency, even those that contradict one another and contradict the commitments that motivate Burge's account.<sup>51</sup> Consequently, these findings suggest a constraint upon accounts of Biologically Basic Agency generally: avoid offering accounts of Biologically Basic Agency that are empirically uncheckable or trivial.

In this chapter (and the next), I turn to discussing Kim Sterelny's (2003) conception of Biologically Basic Agency, which does not suffer the problems faced by Burge's account of Primitive Agency—it is empirically checkable and cannot be made consistent with any other account of agency. Sterelny offers a Common Trajectory version of a Strong Evolutionary account of Biologically Basic Agency. Such accounts identify a common, diversely evolved “simplest” functional type, and then claim that the same general selection pressure will produce the same evolutionary trajectories—the same stages

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<sup>51</sup> Effectively, all that can be substantively retained from Burge's picture are the basic motivations for developing an account of Biologically Basic Agency—that a non-representational agency precedes or grounds human representational agency and the likely representational agency of other animals. Motivations, though, are not an account.

through which all more sophisticated agents will progress—for all instances of the diverse descendants of the diverse instantiators of this simplest version of the biological trait.<sup>52</sup> On Sterelny's view, the simplest kind of agency from which all other more complex agencies will evolve—particularly human-style intentional agency—is the "Detection System." Very briefly, a Detection System generates a single, feature-specific behavior in response to a single sensory stimulus that is associated with the feature the behavior is designed to target.

In discussing the Detection System in this chapter, I have two goals. The first is to establish that the Detection System and its proposed evolutionary role, as Sterelny characterizes it, is beset with deep problems. In light of these difficulties for Sterelny's account, the second goal is to identify further constraints for theories of Biologically Basic Agency. These constraints will work in conjunction with those established in Chapter 1 and Chapter 2.

Sterelny's conception of the Detection System and the evolutionary role it is to play has four critical and potentially fatal ailments:

- 1) The Detection System is too broad a functional type to constitute an appropriate *simplest* behavioral type from which all other more complex agents will evolve.
- 2) Even if (1) could be avoided, the claim that Detection Systems are ubiquitous (which Sterelny needs to be the case to tell any story about how all kinds of agency evolve from Detection Systems) cannot be empirically supported.
- 3) In general, Strong Evolutionary stories of the Common Trajectory variety that Sterelny tries to tell regarding the evolution of all more sophisticated and complex agencies are implausible. (At a minimum, the story is deeply implausible for highly general, functional types like the Detection System.)

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<sup>52</sup> Evolutionary accounts constitute one of two broad approaches to developing an account of Biologically Basic Agency—the two broad approaches form an exclusive disjunction (see Chapter 1). I have called the second broad approach to Biologically Basic Agency "common core" accounts. Briefly: "common core" conceptions of Biologically Basic Agency identify a minimal set of properties that all instances of action and agency—both simple and complex—have in common but does not presuppose or require that instances of the type be homological. Burge (2010) offers a "common core" account.

- 4) Sterelny's account cannot be sustained as a Common Ancestor variety of Strong Evolutionary stories.<sup>53</sup>

Problem (1) will be straightforwardly established by direct appeal to Sterelny's characterization of Detection Systems and the examples he takes to be representative of this type of agent—in particular: chemical gradient following bacteria, corpse removal by ants, fleeing predators in cockroaches, and finding cached food in birds. The ant's, cockroach's, and caching bird's Detection Systems are much more complex and sophisticated than that of the bacterium, both in terms of physiology and the functional organization of their behavioral responses to stimuli. Moreover, the caching birds have capacities that are clearly later evolutionary developments than those possessed by the insects or the bacteria. So, it is not plausible that they constitute a singular simplest behavioral type or trait.

Problems (2), (3), and (4) will be established by broader appeal to the ethological research tradition Sterelny relies upon to furnish examples of Detection Systems in order to establish that they are ubiquitous. This paradigm, focusing on the Fixed Action Pattern and following the work of Konrad Lorenz and Niko Tinbergen, dominated ethology for much of the 20<sup>th</sup> Century. However, like many scientific paradigms of the past, it is now seriously undermined and abandoned. It is undermined because it is no longer tenable to hold that Fixed Action Patterns (which Sterelny takes also to be the clearest examples of Detection Systems) are widespread or typical of organic behavior. Moreover, and germane to problems (3) and (4), one of the reasons that the Fixed Action Pattern research program has been replaced is that it assumed that functionally similar behavioral types, like the sexual behavior of butterflies and fish, were evolutionarily related. This is deeply problematic; inferences to evolutionary relatedness on the basis of the functional similarity of biological traits across different species are not straightforward, and indeed are rarely supportable. This difficulty is amplified in Sterelny's case because he identifies a highly general behavior that is produced by highly diverse species with diverse evolutionary histories. It is unlikely that the members of the Detection System are homologous and so could pass on their shared evolutionary

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<sup>53</sup> Sterelny's account as presented runs a Common Trajectory story, but it will also be useful to show that it cannot work as the alternative evolutionary account as well, as this will illustrate how deep the problems run in Sterelny's account.

past to their descendants. So, it is also unlikely that there is a single identifiable first Detection System from which all others are evolved, and so (4). It is unlikely that a Common Ancestor version of a Strong Evolutionary story can be told regarding the Detection System (and all subsequent kinds of agency that are to descend from the Detection System). Furthermore, given the highly particular nature of evolutionary change within individual organic lineages, it is highly unlikely, generally speaking, that the diverse population of a highly general functional type like the Detection System would typically (and predictably or reliably) evolve into another diverse general behavioral type or follow the same general evolutionary trajectory. So, a Common Trajectory story of the kind Sterelny offers is not plausible generally speaking, and not plausible in the case of the Detection System. The ultimate result for Sterelny's account of agency is that it cannot be made to work as any Strong Evolutionary story.

These general lessons that emerge from discussing the difficulties for Sterelny's view of agency show that we need to modify the guidelines regarding the biological categorization scheme for accounts of Biologically Basic Agency. Effectively, only Common Ancestor accounts of Strong Evolutionary stories are plausible. And so plausible accounts of Biologically Basic Agency have to offer either a Strong Evolutionary story of the Common Ancestor variety or offer a Good Trick style biological category (see Chapter 1).<sup>54</sup>

In order to begin establishing the difficulties with Sterelny's view of Detection Systems and the implications for accounts of Biologically Basic Agency more generally, I will start by describing in the next section the basic picture Sterelny presents of the Detection System. Following this basic characterization, I will then make evident the range of behavioral complexity and sophistication Sterelny believes Detection Systems are capable. With this expository work in place, I can begin the extended critical discussion outlined above.

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<sup>54</sup> Such an approach identifies a broad functional category that has evolved in various lineages in various ways because it is a "Good Trick" or useful thing to do in virtue of being a living organism and having the needs that living organisms often do.

### 3.2. Detection Systems, the basic picture

As noted above, Sterelny begins his evolutionary story with the very simplest agency to be found in nature from which all more sophisticated types will evolve. This simplest type of agency is implemented by the Detection System, which Sterelny introduces in the following way:

I begin with a baseline for thinking about cognition and cognitive evolution: namely those organisms that have mechanisms that mediate a *specific adaptive response* to some feature (or features) of their environment by registering a *specific environmental signal* that tells the organism of the presence of the feature. Many organisms have response systems that are geared in this way to a single cue. Thus cockroaches escape from predatory toads by detecting their presence from the wind gust caused by the movement toward them of the striking toad's head. They are equipped with antennae covered with hairlike wind detectors. When these register a wind gust of appropriate speed and acceleration, the cockroach turns away from the direction of the gust and scuttles for safety in that all too familiar way.... The hygienic behavior of ants and bees—their disposal of dead nestmates—depends on a single cue, the oleic acid decay produces.... Such systems are ubiquitous, for virtually every organism has some capacity to discriminate between different states of the environment and respond appropriately to those differences. Bacteria, for example, can respond to chemical gradients in their environment... (p. 14).

Detection Systems, then, are functionally defined (in terms of inputs and outputs) as discrete, behavioral production and control modules “designed” to produce a single kind of behavioral response that uniquely targets a single feature of the environment. This feature-specific response is “triggered” by the registration of an environmental signal (e.g., light waves, sound waves, chemicals, object pressure on an organism's surface, etc.) that correlates with the environmental feature the behavior is “designed” to target. A Detection System can, therefore, only use this environmental signal to generate this single-feature-directed behavior. If the organism uses this signal to generate any other behavior, a Detection System is not governing the signal-behavior relationship (p. 34). Further, a Detection System cannot generate this specialized behavior in response to the registration of any other environmental signal. An environmental signal and a behavioral response have an exclusive relationship within a Detection System. And under ideal conditions, the environmental feature-environmental signal relationship is

also exclusive, and by transitivity, so is the environmental feature-behavioral response relationship.<sup>55</sup>

However, while the Detection System is supposed to be the simplest kind of agency, it is not only found among the simplest organisms on Earth. It is ubiquitous, according to Sterelny. So, Detection Systems, as discrete behavioral control units, can appear in virtually any organism as part of any combination of behavioral control mechanisms an organism possesses. An organism could have intentional agency (like we have), Detection Systems, and many other kinds of control systems in between producing behavior. However, it is possible for organisms to be controlled exclusively by Detection Systems. Such organisms are labeled “detection agents” (p. 14).

### **3.3. The (unexpected) sophistication of Detection Systems**

Detection Systems seem like they would be very simple. One might imagine them as working just like reflexes—that Detection Systems produce an immediate, simple, quite brief behavioral response to a specific stimulus; something like the sensory-motor loop causes one to kick at the doctor when she strikes one’s patellar tendon, or causes us to duck objects moving swiftly toward our heads, or brings our hands before us as we fall forward. However, as ready as we may be to understand Detection Systems this way, doing so would seriously misrepresent them. Sterelny maintains that quite lengthy and complex behavior aimed at only one feature of the environment can be dependent upon a single sensory trigger (p. 14-15).

Indeed, the range of complexity found in Detection Systems is part of why Sterelny believes he can maintain that the system is ubiquitous. At first blush, this ubiquity of

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<sup>55</sup> Of course, such exclusivity does not always exist in an organism’s environment—sometimes, and perhaps even often, features of the environment that the behavioral system is not designed for will produce the same environmental signal, and thereby trigger an inappropriate behavioral response. On occasion, such responses can get an organism into serious trouble—like when predatory fireflies of one species mimic the mating signal of another species they prey upon. This is the selection pressure Sterelny believes will drive the development of agents less vulnerable to such exploitation. However, I am not here concerned with Sterelny’s claims of the epistemic situation of simple organisms and agents, nor the details of what forces will drive the evolution of behavioral systems. This is because there are serious problems with the base conception of agency Sterelny employs, and the epistemic selection pressures Sterelny believes drive evolutionary change are only clearly relevant if simple agents are as he describes them. So, if the Detection System concept is untenable, the rest of the account is undermined.

Detection Systems may seem like a good thing. But this claim ultimately undercuts Sterelny's position; the Detection System is too broad a functional type, and therefore, too diverse to actually describe the *simplest* agency from which all more complex agencies are to evolve. Some agencies that count as Detection Systems and are more—sometimes much more—sophisticated and complex than others (with some having to be later evolutionary developments) should be at least in part explained by emerging from this basic type. However, they end up included in this basic type from which they are to emerge.

This can be illustrated by unpacking the three examples Sterelny cites as representative Detection Systems in the passage quoted above—the wind-evoked escape of the cockroach, the chemotaxis of bacteria, and the undertaking behavior of ants. This issue can be made glaringly obvious by Sterelny's use of food-caching birds as examples of Detection Systems.

Consider first the cockroach's wind-evoked escape response. It begins with the registration of air moving at a particular acceleration from a particular direction. This triggers a turn away from the accelerating wind, which is, in turn, followed by a relatively short run along the trajectory set by the turn. The run appears to be halted by some internal mechanism or setting. Given the fact that the run stops of its own accord and proceeds along the trajectory set by the initial turn, one might suspect that this run is "blind," but it is not. The run component is informed by visual, antennal, and wind sensor input (Ye et al., 2003). Yet, despite the use of air current information along with other types of stimuli in guiding the run, the wind gust that generates the initial turn of the escape does not play a further role in guiding the cockroach's flight. This means that in this Detection System, the sensory stimuli that guide the running are distinct from the stimulus that triggers the response. This will be identified as Detection System Type C.

In the case of bacterial chemotaxis, the triggering stimulus also serves (essentially exclusively<sup>56</sup>) to guide the triggered behavior through to completion. The registration of a

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<sup>56</sup> Other factors affecting the movement of the bacterium like the pull of gravity and perturbations in the liquid medium the bacteria lives and moves in will affect the movement (movement in response to gravity is called gravitaxis) as the bacterium follows the chemical gradient, but following the concentration of the chemical gradient will itself be dependent on sensory reception of the chemical type alone.

particular chemical (typically indicating the presence of food) initiates and sustains directional swimming up the concentration gradient of a favored chemical (or swimming down the concentration gradient of an unfavorable chemical). Thus, in this Detection System, all that is needed for the bacteria to execute this behavior is a single environmental signal to both initiate and then guide the behavior over time. Let us call this Detection System Type B.

The Detection System at work in the behavior of undertaking ants, however, offers a fusion of the signal use observed in the fleeing cockroach and chemotactic bacteria. Undertaking, as described by Sterelny, is triggered by a single sensory stimulus, oleic acid. The undertaking behavior is then guided or driven by both the triggering stimulus and other distinct stimuli. The ant must locate the dead conspecific by the appropriate (chemical) environmental signal—the oleic acid the corpse emits. Then, once it has located the corpse, the ant must use further visual, tactile, and olfactory inputs (other environmental signals) to pick up the corpse and make its way from where the body was found to the refuse pile outside of the nest (typically where ant species take their dead). Once the refuse pile is reached, the high concentration of fecal matter (registered via the antennae) informs the ant that this is where to leave the body (Sun & Zhou, 2013). Further, if it is the presence of oleic acid produced by the decaying corpse that prompts the undertaking response, then this cue is likely present throughout the removal process and is likely to play a role in continuing to drive the behavior to its conclusion.<sup>57</sup> For this kind of Detection System, the feature-specific behavior is initiated by a single environmental signal that continues to drive this behavioral response while other environmental signals relating to other features of the environment are utilized to guide the behavior through to completion. One of the signals involved in carrying out the behavior, once it reaches sufficiently high concentrations, triggers the end component of the behavior. I'll label this kind of Detection System Type A.

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<sup>57</sup> Sterelny does not cite any source when he makes this claim about ant behavior, but it is most likely derived from Wilson, Durlach, and Roth (1958). In this article it was reported that ants would drag both dead and living conspecifics from the nest so long as they are coated with oleic acid. Given that the live ants were resisting being carried from the nest when this occurred, the ongoing presence of the oleic acid likely causes the undertaking ant to push through this resistance.



Detection System Types A, B, and C do not exhibit the same functional organization with respect to signal input and behavioral output. Detection System Types B and A need to be organized so that more of the inciting stimulus can be used to guide or drive the resultant behavior, so there needs to be some kind of feedback loop enabling the inciting stimulus to continue to drive or modify behavior. Type C, on the other hand, will not require a feedback loop for the triggering stimulus, because this stimulus plays no further role in executing the behavior. Types C and A both require “components” that take in information from other sensory channels (registration of other sensory cues) and use this information to modify and regulate the triggered behavioral response over time. So, Types C and A require sensory input channels “connected” to the element of the Detection System producing the feature-specific motor-behavioral response of the organism. Type B Detection Systems like chemotactic bacteria, though, will not need signals from other channels to direct it toward the more concentrated end of the chemical trail.

This is not intended as an exhaustive list of the differences in the organization of signal inputs and behavioral outputs across Types A, B, and C. However, I do think it is clear, on the basis of the above, that the functional organization of the Detection System implemented by chemotactic bacteria is simpler than that exhibited by ants or cockroaches. I also think that this raises problems for the coherence of the evolutionary story Sterelny wants to tell. It would seem that a simpler system like bacteria should be explanatorily prior in this story to the behavioral system of ants, but Sterelny has placed them on the same explanatory plane; they are, for Sterelny’s evolutionary-explanatory purposes, equally simple or basic. One might be able to perhaps justify this position by some appeal to the fact that each system type uses a single sensory cue to drive behavior, and that this is the correct sorting criteria for deciding what should count as simplest or basic for some further reason.<sup>58</sup> However, this problem becomes more pressing once Sterelny claims that food-caching birds are also controlled by this simplest or basic system.

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<sup>58</sup> This reason could be epistemic—they are both equally dependent on one sensorially acquired source of information to “let them know” what to do right now, though the relevance to the evolutionary story governing which behavioral systems came first is not clear.

### 3.3.1. Birds that cache

There are many species of bird that hide and then retrieve stores of food throughout their environments. To relocate a food store, a bird must rely upon their long-term memory regarding the cache's location. According to Sterelny, when the birds use this stored information to relocate their food, their behavior is the product of a Detection System. This is because this information, despite being stored and retrieved rather than used at the time of sensing or perceiving, "is still special purpose; it powers only a specific kind of behavior" (p. 34). Essentially, then, an organism's behavior is controlled by a Detection System so long as the information, whether contained in an occurrent sensory registration or a memory, is used to guide the behavior; it can only be used to initiate and control this single kind of behavior that is only suitably aimed at a single feature of the environment.

The trouble here begins with the fact that long-term memory and perception (or sensation) are different (though related) functional kinds. So, it is likely that behavioral control systems that utilize long-term memory of the location of items in the environment trigger a behavior (which will be guided by further sensory input and memory, like the caching birds) are at least more functionally complex (has more functional unit types) than the use of a single sensory input to initiate and modify directional movement (like chemotactic bacteria). Moreover, and more importantly, beyond the difference in the functional organization of bacteria and caching birds, neural-representational storage of the location of previously perceived objects or environmental features (found in birds and mammals) is a later evolutionary development relative to the ability to register a sensory signal (Sherry, Vaccarino, Buckenham, & Herz, 1989; C. C. Smith & Reichman, 1984). So, it is unlikely that a single-celled organism producing a change in swimming direction in response to a single sensory stimulus and a bird's memory-stimulated (and guided) food cache retrieval instantiate the same *elementary* functional type of behavioral control system from which all more sophisticated and complex control systems will evolve.

Sterelny's focus on the idea of "special purpose"—that if an organism only uses sensory or memory information for a special purpose or to only "power one behavior," then it instantiates the simplest kind of agent or offers a baseline for thinking about human agency—has muddied the water as to what kinds of behavioral systems must be evolutionarily prior to others. I think the case of the caching bird makes it clear that the

Detection System includes far too much, given the role it is to play in the evolutionary story Sterelny wants to tell. The simplest behavioral systems that are supposed to give rise to more complex or sophisticated ones should not include the more complex or sophisticated behavioral types it is supposed to precede. Therefore, it is difficult to see how Sterelny could hope to tell a coherent story about the evolution of more complex agencies from the Detection System using the present conception of the Detection System. At a minimum, this establishes that Sterelny's "baseline" for thinking about the evolution of agency needs further justification. This point will become more relevant in section 3.4.4 below.

### **3.4. The supposed ubiquity of Detection Systems**

I think that someone might try to hold on to Sterelny's view by adopting the following sort of reasoning. Sterelny has perhaps not identified the *simplest* adaptive behavioral type (agent), but he has identified a clearly existing type. After all, Sterelny has identified examples (and the ethological literature is full of examples) of highly stereotyped behavior that is appropriate to only one environmental feature and is triggered by one stimulus or information source. So, perhaps Sterelny has identified a type "at the right level" for the beginning of the general evolutionary story he wishes to tell. The category would still have explanatory usefulness if the general evolutionary story he is trying to tell can still be told using the category he has identified, regardless of whether it is in fact the very simplest kind of agency or not. Perhaps, then, the Detection System can be counted as "basic enough," and a general evolutionary story can be effectively told about the move from Detection Systems to other agentive systems.

However, this line of reasoning depends upon two key elements of Sterelny's view that need to be carefully examined. The first is that feature-specific, single cue triggered behavioral systems are typical and widespread. The second is that a general evolutionary story of the kind Sterelny (and someone defending him in the manner above) wants to tell is a *plausible* type of evolutionarily story. In what follows, it will become clear that neither claim is tenable. The way the empirical and theoretical findings have turned out in ethology over the last seventy or so years seriously undercuts them both.

### 3.4.1. The evidence base for the ubiquity of single feature directed, single signal triggered behavior

Those who would side with Sterelny in holding that specific, single stimulus driven behavioral systems (like the Detection System) are ubiquitous in nature as well as in the ethological literature have in mind the research tradition that followed the work of Konrad Lorenz and his student Nikolaas Tinbergen. They initially developed and explicated the concept of a Fixed Action Pattern.<sup>59</sup> A Fixed Action Pattern is, more or less (according to the consensus reached on the use of the term in the literature at a symposium of the Society for Experimental Biology on Animal Behavior in 1948):

An inherited relatively complex movement pattern within instinctive behavior, which is as characteristic of the species or group as are structural features. The intensity of discharge may vary, but its form is little, if at all, modifiable by external stimuli. (Thorpe, 1951 as cited in Schleidt, 1974, pp. 184-185).

A Fixed Action Pattern, then, is a highly stereotyped, heritable and “innate” (unlearned) pattern of movement that is seen in a species (or genus, or family) and is characteristic of a cladistic grouping, in the same way that structural features—like feathers in birds—are. One key feature of them is that once triggered, they tend to run to completion,

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<sup>59</sup> One might think that Sterelny and those who would side with him have in mind the “feature detection” concept from neuroethology when formulating his account of Detection Systems. But “feature detection” in neuroethology is about identifying particular, specialized neural mechanisms—typically single “on-off” ganglion cells—identified in particular species or clades. The first example in the literature is the fly detector ganglion cells of frogs (Barlow, 1953). These ganglion cells were supposed to work as a filter rejecting unwanted information and passing along the desired information on to the brain. Little black dots flying about trigger the cells, and their presence, location, and direction of movement are then passed on to the brain for the production of tongue-lashing. A further condition of feature detectors is that nothing else (under most circumstances) is passed on to the brain by these cells. However, belief in feature detectors of this sort among ethologists is virtually non-existent because it is typically now thought that “object recognition is not the product of single detector cells but of neuronal networks”—and so this idea is rather passé in neuroethology (as of 1994). Indeed, “feature detectors” is now used quite broadly. The term will also be used to refer to specialized parts of the brain that respond almost exclusively to particular stimuli, but this is only after some prior processing by the neural machinery of the sensory system projecting to this specialized part of the brain. Moreover, this understanding of detection is not Sterelny’s notion of detection—this version of what a detector is is defined in terms of the mechanisms that implement the detector—and only certain kinds of mechanisms count as detectors in this sense, i.e., single on-off cells—rather than broader networks. Sterelny’s concept of detection is mechanism independent—neural networks, etc. can count as the mechanisms implementing a “detector.” So, this literature is not directly supportive of Sterelny’s characterization of Detection Systems because detectors understood in this way cannot be readily or widely identified, and such an understanding of detectors stipulates certain mechanisms or functional organizations that play the role of detectors (Roth & Dicke, 1994).

regardless of the changes in the environment. (So, while they might require further environmental stimuli to run their course, further stimuli will not halt the behavioral routine.) Not included in this particular characterization of the Fixed Action Pattern is the further notion that there are specific sensory stimuli that trigger these rigid behavioral patterns, though they can occur “spontaneously” (Schleidt, 1974).<sup>60</sup>

This tradition was highly influential and much was published in this vein from the 1930s to the 1970s, extending into the 1980s (Brigandt, 2005; Roth & Dicke, 1994; Schleidt, 1974). And while I think it is highly likely this is the literature someone inclined to support Sterelny’s account has in mind,<sup>61</sup> it is certainly the body of research Sterelny has in mind when developing the Detection System model.

Sterelny’s Detection System concept is very similar to the Fixed Action Pattern. In both conceptions, a single stimulus type connected to a single environmental type produces a behavioral response “designed” for only that feature. But there is more than mere similarity linking the concepts. Sterelny employs key illustrative examples that are popular in the tradition—like the mating ritual of the great crested grebe (p. 18)—as examples of Detection Systems. The mating routines of birds like the grebe were popular objects of study in this tradition (Miller, 1988; Moltz, 1965; Tinbergen, 1942, 1952; Wenzel, 1992). Moreover, Sterelny explicitly cites Tinbergen’s *The Herring Gull’s World* (1961) (Tinbergen, 1961) as “a classic demonstration of the operation of these Detection Systems in the herring gull” (p. 27). It would be difficult to deny, in light of this evidence, that the Fixed Action Pattern research tradition is Sterelny’s source for the notion that feature-specific, single sensory trigger behavioral systems are common and widespread.

Beyond using the Fixed Action Pattern tradition as a source of examples, Sterelny also relies upon portions of the tradition’s conceptual and methodological machinery when addressing the issue of how one is to tell which environmental signal, exactly, is driving an organism’s behavior. Regarding this issue, Sterelny says, “If the organism is cue bound, we ought to be able to construct a single optimum cue, a visual [or other]

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<sup>60</sup> Eventually, as the concept developed, FAPs could be learned as well as innate (Moltz, 1965; Roth & Dicke, 1994).

<sup>61</sup> It is often cited in the philosophical literature. See Bermudez, 2003; Burge, 2010; Dennett, 1996; Dretske, 1988; Godfrey-Smith, 1996. Note that I do not take all of these individuals to number among those willing to defend Sterelny’s views. The point is just that this is a common touchstone in the literature.

stimulus that elicits the strongest response” (p. 16). The search for sensory cues that would elicit the strongest behavioral responses in animals was a significant part of the Fixed Action Pattern research program (Hogan, Kruijt, & Frijlink, 1975; Roth & Dicke, 1994; Staddon, 1975; Hogan et al. 1974; Staddon 1975). Many studies in this tradition identified “supernormal stimuli”—stimuli that were exaggerated forms of the natural or “selected” stimuli that drove Fixed Action Patterns more intensely than the natural stimulus that “normally” drove the behavior under investigation. One of the most striking examples is that of the oystercatcher (a kind of wading bird). This bird was shown in experiments to prefer, over their own naturally produced eggs, experimenter-constructed eggs several times the size of the natural eggs (Tinbergen, 1951). So, the more like the artificial stimulus an object was, the more intensely it would drive this behavior, and the less like this artificial stimulus an object was, the less intensely it would drive the response. It is fairly clear that Sterelny’s thinking on this matter is virtually identical to that found in the Fixed Action Pattern tradition.

### **3.4.2. The poverty of the Fixed Action Pattern**

Unfortunately for Sterelny’s view and any view like his, reliance upon, and great similarity to, the Fixed Action Pattern research tradition in this way creates a problem. Even relatively early in the Fixed Action Pattern’s life cycle (Lehrman, 1953), it was pointed out by critics that further examination of proffered examples of Fixed Action Patterns failed to meet the criteria of a Fixed Action Pattern in all dimensions (Wenzel, 1992). And as the study of exemplar cases of Fixed Action Patterns continued, many classic examples of Fixed Action Patterns were found to not fit the model, like the pecking of pigeons (Hörster, Krumm, Mohr, & Delius, 2002), the mating rituals of birds (Miller, 1988), and the digging behavior of *Sepia officinalis*, a kind of cephalopod mollusk (Mather, 1986). These behavioral responses were much more variable, graded, and generalized (produced in the presence of more than one triggering stimulus) than was originally believed and so inadequate for exemplifying the Fixed Action Pattern. (See Roth and Dicke (1994) for an explicit treatment of the concept’s serious shortcomings.)

Moreover, as things stand now, the Fixed Action Pattern and the notion of specialized, single stimulus-bound, inflexible behavioral response is used primarily to model abnormal or dysfunctional behavior like the compulsive pecking of feathers by birds in captivity, and obsessive-compulsive disorder and Tourette’s syndrome in humans.

(Berridge, Aldridge, Houchard, & Zhuang, 2005; Bolton, 1996; Dixon, Duncan, & Mason, 2008; Rapoport, 1990). So, highly stereotyped and specialized, single stimulus-bound behavior is not understood to be broadly typical or healthy organism behavior.<sup>62</sup>

The significance of these results is that they demonstrate that the first claim Sterelny needs to be plausible in order to tell his intended evolutionary story—that Detection Systems are ubiquitous—is not plausible. If Detection Systems are non-existent or sparsely distributed, the general evolutionary story using the Detection System as the simplest, foundational, ubiquitous behavioral type cannot be told because there is no general type to begin the story with.

Thus, given the lack of evidence for this behavioral type's being typical and widespread, Sterelny's view is substantively undermined. In other words, even if we ignore the problems raised in the earlier discussion regarding the diversity of functional types in the "basic" type, there is no basic type of the sort Sterelny needs.<sup>63</sup>

### **3.4.3. The Fixed Action Pattern tradition and homology**

However, the fact that feature-specific, single signal triggered behavioral systems like Detection Systems are not typical of organic behavior generally is not the only problem facing Sterelny's account, nor is it the most serious problem. Sterelny needs the kind of general evolutionary story he is telling to be a plausible kind. However, the kind of general evolutionary story he wishes to tell regarding the transition from a basic, general behavioral type to other less basic general behavioral types very likely cannot plausibly or coherently be told. I will illustrate this by first examining how the problem manifested in a more limited way within Fixed Action Pattern research and thereby undermined the research. I'll then move on to show how this problem is amplified in Sterelny's work.

The Fixed Action Pattern centric research program had a homology problem. This paradigm commonly treated functionally similar behaviors found in different species as implementing evolutionarily homologous Fixed Action Patterns. So, presumed Fixed

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<sup>62</sup> This is not to say that highly stereotyped behavior of this kind does not exist, but simply that it is not typical, widespread, or representational of animal behavior.

<sup>63</sup> Further, even if it turns out that some of Sterelny's examples are single function, single environmental signal triggered behaviors, the claim that such behavioral types are ubiquitous is still undermined.

Action Patterns, like the sexual behavior of butterflies and fish (Tinbergen, 1942) or the movement of amoebae and neonate humans toward weak stimulation and away from strong stimulation (Lehrman, 1953), were also presumed to be homologous.

The problem here is that functional similarity of two traits does not license a direct inference to evolutionary homology regarding this “shared” trait. Functionally similar traits are very often merely *analogous* traits—those that are similar, have the same function, or serve the same purpose (like the wings of most birds compared with those of bats), but are not descended from a common ancestor. So, they cannot be evolutionarily grouped together on the grounds of homology. Moreover, the explanation of how bird wings evolved, under what conditions and selection pressures, what initial functions they had, and their ancestral forms will not be the story that is told for the evolution of the bat wing (or insect wings or theropod wings) (Bowlin, 2016; Heers, Baier, Jackson, & Dial, 2016; Medved et al., 2015).<sup>64</sup> Therefore, simply establishing similarity of function of biological traits in distinct species does not establish homology or even similarity of evolutionary sequence. Nor does it establish similarity or identity of the mechanical or functional implementation (which functionally identified units perform which roles in implementing the larger function) of functionally similar traits.

So, while the behavior of infants and amoebae with respect to weak and strong stimuli might be functionally similar, and so too might the sexual behavior of butterflies and fish, this alone does not entail that each pair of behavioral traits are homologous. There is also no guarantee that the functionally similar traits developed and were then preserved in each lineage because of similar selection pressures. Indeed, it is likely that the initial development of the behaviors and selection conditions were quite different given the very different evolutionary origins, anatomies, physiologies, and environments of fish and butterflies. Furthermore, even if the selection pressures operating in both lineages were similar, these similar behavioral types have evolved from different ancestral precursors and are therefore very likely modifications of mechanisms or the functional organizations of mechanisms not held in common between fish and butterfly lineages.

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<sup>64</sup> The consensus is that bird wings evolved initially to assist running and bat wings evolved initially for gliding.



More generally, this means that the functional properties of a behavioral type, the mechanisms that produce the behavior, and the evolutionary history of the behavioral type can all come apart. Homologous mechanisms can implement distinct behavioral functions, while similar functions can be implemented by different mechanisms (and different functional organizations of those mechanisms), and animals with distinct evolutionary histories can evolve similar mechanisms that perform similar functions. Thus, to drive the point for the Fixed Action Pattern: it cannot be merely presumed that because there is a similarity in the function of a behavioral type observed in two (or more) species that we have found behavioral functions that are homologous or that the same evolutionary story regarding selection pressures or the stages through which a trait emerged can be told.

#### **3.4.4. Detection Systems, homology, and evolution**

The Detection System concept, because it is a much more general category than any single Fixed Action Pattern could be, fares even worse regarding homology, function, and mechanism. There is vanishingly little plausibility for a claim that the Detection Systems constitutes a homologous group, given the diversity of examples Sterelny offers as exemplars and examples he would likely accept. So, the starting point for the kind of evolutionary story Sterelny would like to run will not have a common evolutionary heritage to pass on to the types of agency that are to evolve from them. Moreover, the sense modalities involved in the various Detection Systems and the varieties of behavioral output will be implemented in highly diverse ways by vastly different anatomies, physiologies, and functional organizations coordinating sensory-behavioral relations. So, even if all Detection Systems face the same general selection pressure(s) (as Sterelny believes)<sup>65</sup>, it is unlikely that their descendants will, or have, adapted to these challenges in the same or similar ways.

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<sup>65</sup> Indeed, Sterelny does believe that Detection Systems evolve into more sophisticated agencies on the basis of a singular selection pressure. Sterelny notes that environments are not always transparent—that is, an environmental signal that correlates with a particular feature of the environment does not always correlate with only that feature of the environment. Oftentimes, environmental signals are ambiguous with respect to the feature of the environment that is present right now. So, organisms with Detection Systems will sometimes, and perhaps often, produce a behavior that is well adapted to one feature of the world in the presence of another. And sometimes, this will be injurious, fatal, or otherwise costly. Such environments are

As a general rule, sorting out the evolutionary relationships between the traits of organisms is a difficult business—especially for behavioral traits—because of the very particular nature of the evolution of species (Laudner, 1999). The particular instances of Detection Systems with their particular physiologies etc. will have differing resources with which to adapt to the selection pressures they face. So, two organisms with distinct sets of physiological features may well take different paths to solving the “same” problem. Moreover, the general selection pressure—whatever it happens to be<sup>66</sup>—will itself have different manifestations for the different Detection Systems—different environmental features will be relevant for different organisms. The particular organisms, with their particular Detection Systems, implemented by particular physiologies and anatomies, and their particular environment or selective circumstances, will evolve in their own particular way. So, given the lack of homology amongst Detection Systems and thereby amongst their descendants, and the particular, lineage-specific nature of evolutionary explanation, it is highly unlikely that Detection Systems or other highly general functional types will evolve in an orderly fashion such that a singular, unified story regarding how they all will evolve into the same next kind of agent or along the same trajectory. Consequently, Sterelny’s picture of the Detection System cannot be made to work within a Strong Evolutionary story of the Common Trajectory variety

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“translucent.” Further, some translucent environments are “hostile”—other organisms send “false” signals out into the environment with the purpose of eliciting the “wrong” behavior from an organism that is dependent upon a Detection System for aligning its behavior with the features of its environment. Thus, it would be good for organisms if they could more reliably determine whether the feature of the world to which they respond with a single behavior is present. Hence, these selection pressures will favor organisms that use two or more cues to determine whether the relevant feature of the environment is present or not, rather than one. Sterelny calls such systems “robust tracking systems,” and they are the next universal step up from the Detection System on the evolutionary ladder of agency (p. 20-29). After the robust tracking system, there is less rigidity. The evolution of agency will follow at least one of two tracks toward human agency. The first is where more and more cues will become relevant to a single behavior, and so the behavior will be produced in response to a variety of cues, and, likely, features of the environment. The second track is the inverse. An increasing array of behaviors can be brought to bear upon a single cue or feature of the environment. As one approaches human agency, one approaches the possession of “decoupled representations,” which, among other things, allow human agents to apply any behavior to any feature of the world, and so behavioral response is maximally decoupled from environmental features and cues (p. 33-35).

<sup>66</sup> This is why it is not necessary to spell out Sterelny’s evolutionary story in the main text—the details do not even come into play, given these general evolutionary confounds.

(which is the sort he develops), nor can the Detection System be utilized to develop a Strong Evolutionary story of the Common Ancestor variety.<sup>67</sup>

### 3.5. Conclusion

The kind of evolutionary story Sterelny wants to tell about the Detection System and agency runs into four serious problems (identified briefly above in Section 3.1).

1) It was established that the Detection System does not identify a clear or coherent conception of the *simplest* agents from which all others will evolve. Rather it picks out a much more general type, which includes agents of varying levels of sophistication and complexity, including some that certainly occur much later in the evolutionary story of life than others—like the long-term memory-involving behavior of caching birds as compared to the chemotaxis of bacteria. This essentially makes agents whose emergence should be explained by emergence from this simplest type part of the simplest type, and further means that the requisite simplest type of agency has not been identified.

2) Even if (1) could be avoided by some means of showing that all of the identified Detection Systems are truly “simplest” in some coherent sense, Sterelny needs Detection Systems to be typical and widespread, or “ubiquitous” (p. 14). However, this position cannot be empirically supported. Sterelny’s own key examples do not instantiate examples of Detection Systems. Furthermore, the ethological research tradition Sterelny

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<sup>67</sup> It is important to note that the implausibility of telling a unified evolutionary story regarding agency remains even if we were able to identify a single ancestral organism with a particular Detection System’s physiological implementation from which all other more complex forms of agency evolved. Common ancestors can be identified for traits without the same evolutionary story being applicable to two distinct descendants of that common ancestor. Our bipedalism and that of birds has a deep common ancestry in the earliest tetrapods. This, however, does not entail that these broadly similar functional types have similar evolutionary explanations such that the same principles, selection pressures, etc. will underwrite a unified evolutionary story for both traits. So, even if a single Detection System ancestor were to be discovered, this does not entail that the same evolutionary story could not be told for the agency of its various descendants—such stories would have to be lineage specific. So, in order to construct an even remotely plausible version of the Detection System focused evolutionary story Sterelny wishes to tell, one would have to show, at a minimum, that: 1) It is plausible that a singular ancestral Detection System or a small set of homologous ancestral Detection Systems existed for all more sophisticated kinds of agency, and 2) The only wide-ranging evolutionary story that could be appended to these conceptions of the Detection System would be one that charts the various ways in which agency develops in the various lineages that descend from the shared ancestral Detection System(s).

depends upon for some of his examples of Detection Systems and for supporting the ubiquity claim (which is built around the Fixed Action Pattern) has been rejected. Though this tradition identified a number of specific behaviors triggered by single environmental signals, further research showed that these behaviors could not be coherently interpreted this way. Such models of animal behavior are now taken to effectively model *dysfunctional* behavior, rather than typical, healthy animal behavior.

3) and 4) The Fixed Action Pattern research tradition Sterelny relies upon was also abandoned because it made a number of unsupportable inferences from the functional similarity of behavioral traits—like sexual behavior across distinct species—to the evolutionary relatedness of these behavioral traits. A similar problem manifests more strongly for Sterelny. The large number of diverse organisms possessing diverse evolutionary histories, ancestors, mechanisms, and functional organizations that are supposed to implement Detection Systems makes it virtually impossible to tell Strong Evolutionary stories of either a Common Ancestor variety or a Common Trajectory kind (which is the sort Sterelny offers). So (4), the almost certain lack of homology among Detection Systems means that there is no common ancestral Detection System to confer the property of agency to all Detection Systems and their descendants. And (3), given the very particular nature of evolutionary change within individual organic lineages, it is extremely unlikely that the diverse members of a highly general functional type like the Detection System would typically and predictably (reliably) evolve into another diverse general behavioral type or follow the same general evolutionary trajectory.

In summary, Sterelny's conception of the Detection System cannot play the role of the simplest kind of agency from which all others will evolve, and the basic kind of evolutionary story he wants to run—the Common Trajectory type of a Strong Evolutionary story—using the Detection System (whether it is a sustainable conception of the simplest kind of agency or not) is also deeply implausible. These results not only rule out Sterelny's account of Biologically Basic Agency, but further refine what is required of evolutionary accounts of Biologically Basic Agency that seek to identify a common ancestral type for all subsequent kinds of agency.

The constraints on biological categorization (introduced in Chapter 1) are now refined in the following way. The two options for identifying an analysis of Biologically Basic Agency as a coherent biological category are now:

- a. The first approach is to offer a Common Ancestor version of a Strong Evolutionary story—one that identifies a common ancestor agent from which all later agents have evolved (and so one possesses agency in virtue of inheriting that trait from a single shared ancestor). (We have just seen that the second variety of Strong Evolutionary stories—Common Trajectory accounts—are generally not plausible, and so we ought to remove that option from guidelines aimed at generating a plausible account of Biologically Basic Agency.)<sup>68</sup>
- b. The second approach is to identify a broad functional category that has evolved in various lineages in various ways because it is a Good Trick or useful thing to do in virtue of being a living organism and having the needs that living organisms often do. Such an account, though, does not presume a common ancestor from which all instances of the biological trait have evolved (as in a Common Ancestor variety a Strong Evolutionary story). Nor does it presume that there is a uniform set of evolutionary stages that all instances of the type will have followed from a simplest (independently evolved) version of the type (as in a Common Trajectory Strong Evolutionary story). Biological traits like camouflage, heterotrophy, and autotrophy constitute examples of this sort of biological classification scheme.

With these refinements in mind, I can now push further into undermining the idea that the simplest sorts of agents that can be found in nature will be like Detection Systems—that they will produce a single behavioral response to a single feature of the environment.

### **3.5.1. Moving forward**

This basic picture of the simplest agency as the production of inflexible, feature-specialized behavior (often produced in response to a single sensory cue) is deeply intuitive and is a fairly popular philosophical view (see, for example, Bermudez, 2003; F. Dretske, 1988; F. I. Dretske, 1995; Godfrey-Smith, 1996; Mandik, 2005; Mele, 2003;

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<sup>68</sup> Though as we have seen, the Detection System, as characterized by Sterelny (2003) will not work in a Common Ancestor story, but Common Ancestor stories are still a viable means by which we can group biological traits.

Sterelny, 1991). It is easy to imagine that someone, despite the difficulties for Sterelny's conception of the Detection System, and despite evolutionary accounts of Biologically Basic Agency being restricted to Common Ancestor stories, may still be firmly committed to the idea that the simplest agents in nature will turn out to be like Detection Systems. They might claim that the problems I have identified for Sterelny's Detection System emerge only because he tried to cover far too much with his account—to tell too general a story with too general a behavioral type. Therefore, they could go on: if we appropriately restrict Sterelny's notion of the Detection System—say to only very simple organisms like single-celled organisms—and focus on the simple sensory inputs like light intensity, chemical compounds, etc. and behavioral responses like moving away or toward a stimulus, then we will find Detection Systems where we should. And, as a result, it may be possible to run a Common Ancestor story with this tweaked conception of Detection Systems.

In order for this line of reasoning to work, it must, at a minimum, be plausibly established that inflexible, feature-specialized behavioral systems are typical of the behavior of very simple organisms. So, in the next chapter I test whether or not this minimum requirement can be met by applying this modified notion of the Detection System—feature-specialized adaptive responses—to the behavior of very simple model organisms of the sort we should expect them to correctly model. However, once this is done, it becomes evident that even the behavior of very simple organisms cannot be modeled as producing single-feature-specialized responses. Rather, it will turn out that simple organisms are generalists—they use a single orientational behavioral type to adjust their position relative to multiple survival-relevant features of their environment at the same time in order to balance the various costs and benefits associated with them.

## Chapter 4.

### The Detection System: Part 2

#### 4.1. Introduction

In the last chapter, I examined Kim Sterelny's (2003) account of the Detection System. The Detection System is a general, functionally identified behavioral type that produces "a specific adaptive response" to a single feature of the world that is triggered by a "specific environmental signal" (typically a sensory input) that is caused by, or otherwise co-occurs with, the behavior's target feature (p. 14, 34). The Detection System is, on Sterelny's view, the simplest kind of agency from which all more sophisticated and complex types of agency are to evolve. This general functional type is, therefore, supposed to be widely distributed amongst organisms; it is to be found in a variety of organisms from a variety of evolutionary lineages implemented by a variety of mechanisms, from bacteria to primates. Sterelny offers what I have labeled a Common Trajectory version of a Strong Evolutionary account of Biologically Basic Agency. Sterelny's Common Trajectory account of agency runs into two serious problems. The first is that the Detection System is not a ubiquitous behavioral type. The research program (which Sterelny relies upon for many of his examples of Detection Systems) that sought to establish this is long abandoned in ethology; single purpose behaviors like those Sterelny identifies are now models for dysfunctional behavior rather than the normal, typical behavior of organisms. The second problem is that Strong Evolutionary stories of the Common Trajectory type are, in general, deeply implausible, but are particularly so when applied to highly general functional types like Detection Systems. Moreover, without appeal to such a general principle, Sterelny's class of Detection Systems covers too many diverse species with diverse evolutionary histories and mechanisms for implementing Detection Systems to sustain such an evolutionary account of agency. Therefore, Detection Systems, as formulated by Sterelny (2003), cannot be used in a Common Ancestor account either.

However, conceptualizing the simplest sorts of agents or the foundational precursors to our own kind of agency as producers of inflexible, feature-specific (signal-specific) behavior is deeply intuitive.<sup>69</sup> This is likely why it is not an uncommon philosophical position (see, for example, Bermudez, 2003; F. Dretske, 1988; F. I. Dretske, 1995; Godfrey-Smith, 1996; Mandik, 2005; Mele, 2003; Sterelny, 1991). Someone compelled by this intuition and sympathetic to Sterelny's project might think that we should not be so quick to dismiss Sterelny's (2003) basic conception of the simplest agents, and that his problems are the result of trying to include too many different behaviors, evolutionary lineages, and behavioral mechanisms in the class of Detection Systems. So, if we were to modify Sterelny's picture somewhat and restrict the Detection System to the very simplest organisms we could find on Earth—single-celled eukaryotic organisms and very simple animals, and their simple behavioral responses to environmental stimuli—we might be able to show that the basic Detection System model holds at these lower levels. After all, we did evolve from both single-celled eukaryotic organisms and simple animals similar to those occupying the planet now. So, if we can find Detection Systems—or something very much like the Detection System—at either level, we have reason to believe that such behavioral systems were present in our single-celled or simple animal ancestors. Thus, if the model can accurately describe the behavior of such organisms, it provides the first step in establishing the claim that our sophisticated agency did actually evolve from something very much like the Detection System, as Sterelny describes it.<sup>70</sup> We would be able to offer a Common Ancestor version of a Strong Evolutionary story for the Detection System (and subsequently emerging kinds of agency).

In this chapter I will test this attempt to preserve Sterelny's (and others') basic picture of the simplest sorts of agents and their status as the progenitors of our own kind of agency. To do so, I will apply the Detection System concept, appropriately restricted, to two behaviors produced by two "simple" model organisms that one would expect, if

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<sup>69</sup> This sort of behavior is "inflexible" not because it cannot be adjusted to changes in the feature of the environment, but because it can only be appropriately or effectively applied to that single feature.

<sup>70</sup> At this level of discussion regarding the Detection System, the constraints on evolutionary views that I established in the last chapter do not yet come into play. In order to test a Detection System model of the simplest agent from which all others will evolve, there first has to be some good grounds for thinking that Detection Systems exist at the relevant biological levels.



Sterelny's basic idea is right, to be instances of specialized behavioral responses to a single environmental stimulus. The behavior and model organisms I will employ here are the swimming toward a light of the single-celled alga *Chlamydomonas reinhardtii* and the diel vertical migration of the tiny crustacean *Daphnia pulex*. I have chosen to use model organisms because such organisms are used to study various biological phenomena on the assumption that the findings with respect to such organisms will hold generally for other organisms of similar types, not merely for the specific organisms studied.

Therefore, the conclusions I will establish for *Chlamydomonas reinhardtii* and *Daphnia pulex* are likely to hold more generally for organisms of similar biological complexity, environmental situation, etc. (and may hold even more broadly).

In trying to apply the Detection System model to these organisms (and their respective behaviors) it will become evident that, even in these very simple cases, their adaptive behavior (particularly adaptive motile behavior) is not typically specialized for a feature or signal as Sterelny and others imagine.<sup>71</sup> These findings, along with those of the last chapter, show that it is highly implausible that, at any level of organic sophistication, feature-locked or signal-locked behavioral types can be identified in order to ground any story regarding the evolution of our—or any other—kind of agency.<sup>72</sup> Instead, we will find that organisms “at the lowest levels” like *Chlamydomonas reinhardtii* and *Daphnia pulex* adjust a continuous orientational behavior (swimming) in light of a number of survival or self-maintenance relevant features of their environment (along with their associated signals) toward a “best overall” or “compromise” position, relative to those various elements. I call such behavior Utopic.

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<sup>71</sup> Frankly, if behavior is understood as any organism generated (or organism part generated) change in the organism, virtually every behavior of an organism will be determined by multiple concerns and features within and without the organism. I focus on the movement of a cell through its environment in this chapter because 1) most of Sterelny's examples of Detection Systems involve movement around the environment or refraining from (or inhibiting) movement, and 2) I think we typically think of agency as involving movement of one's body, and this appears, at least to me, to be a very natural feature of the behavior of simple organisms to focus upon. However, as we will see in the last section of this chapter and in the next chapter, some analyses of agency at the most basic biological level encompasses essentially all behavior by an organism. So, such views would reject a movement centric analysis of agency.

<sup>72</sup> It also follows, as a corollary, that inflexible behavior of the type described by the Detection System will not be a useful biological contrast case for our own agency, however general and flexible our agency may appear. Though, some may want to hold onto this kind of inflexible system as a formal possibility for building simple computer or machine agents (see Mandik, 2005, for example).

It is reasonable to think, on this basis, that ours and other sophisticated agencies will have developed from—or within the context of—a flexible behavioral regime like that exhibited by Utopic Behavior. Straightforwardly, then, the Utopic Behavior exhibited by organisms like *Chlamydomonas* and *Daphnia* suggests itself as an obvious candidate for an appropriate and effective analysis of Biologically Basic Agency. However, in this chapter, I can only raise the possibility that Utopic Behavior can provide a plausible conception of Biologically Basic Agency, and must leave the evaluation of this position to Chapter 5. I turn, then, to applying the simplified Detection System to *Chlamydomonas reinhardtii* and *Daphnia pulex*.<sup>73</sup>

## 4.2. The Detection System and *Chlamydomonas reinhardtii*

*Chlamydomonas reinhardtii* is favored as a model organism due to its phylogenetic situation between plants and animals (Merchant et al., 2007; Valledor, Furuhashi, Hanak, & Weckwerth, 2013). It is particularly well studied for its basic phototaxis (directed movement in response to light stimuli), which is extensively utilized by life on this planet.<sup>74</sup> Many organisms, like *Chlamydomonas reinhardtii*, rely directly on the sun for energy, and most life on Earth uses light to regulate various life processes (Gehring, 2014; Hegemann & Berthold, 2009; Kreimer, 2009). For most organisms on Earth being able to adjust one's environmental position relative to light would be quite useful. Furthermore, light is an extremely rich information source for navigation and guiding movement. It is not surprising, then, that the ability to guide one's movement using light was preserved and "improved" on over the course of evolution.

For life on this planet, though, light is not an unqualified good.<sup>75</sup> This is especially so for single-celled photosynthesizing organisms like *Chlamydomonas reinhardtii*. Illumination of just the right intensity enables efficient photosynthesis, but light that is too bright can readily damage the alga's single-celled body, resulting in serious injury or death. To

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<sup>73</sup> See Pollon and Akins (2014) for an earlier use of these model organisms to argue against the plausibility of the Detection System concept from a different perspective focusing on the nature of sensory processing and the typical lack of considering mechanisms of implementation when offering evolutionary accounts of things like perception, intentionality, cognition, and agency.

<sup>74</sup> This is to say little about phototropism, which is exhibited by plants fixed to the ground when they grow toward their light source.

<sup>75</sup> Sunlight will cause radiation burns on our skin and can cause fatal cancers.

cope with light's dual nature, algae like *Chlamydomonas* produce positive phototaxis in response to light that is not too intense, and they produce negative phototaxis in response to light that is too intense.

*Chlamydomonas reinhardtii* is able to respond to light in this way in large part because of its single orange-red eyespot or "light antenna." This eye measures about 1 micrometer in diameter and sits on "one side" of the alga's slightly egg-shaped 8-micrometer diameter body at about the mid-point of the cell's front-back axis. (As one might imagine, the eyespot stands out quite starkly against the alga's green body.) Light input to the algal eye causes an alteration of the breaststroke-like beating of the cell's propulsive organelles, which consist of two flagella—thin, whip-like structures resembling hair—located at the cell's anterior. The flagellum nearest the algal eye is designated the cis-flagellum and that farthest from the eye is called the trans-flagellum. The light-induced modification of the flagellar beating pattern moves the cell toward or away from light, depending on the intensity of the light stimulus.

On the basis of the description of *Chlamydomonas*' behavior to this point, one inclined toward a Sterelny-style view might naturally conclude that the positive and negative phototaxis of these algae are controlled by two distinct Detection Systems. One Detection System produces a specialized behavioral response to lower intensity light, and the other produces specialized behavioral response to higher intensity light. As natural a position as this may be to take, it cannot be maintained once the phototactic behavior of *Chlamydomonas reinhardtii* is investigated in detail. In order to get the clearest picture of why this is so, it will be helpful to first understand the "default" swimming *Chlamydomonas reinhardtii* exhibits in the dark, which is then modified and complicated by the introduction of light stimuli.

#### **4.2.1. Dark swimming in *Chlamydomonas***

In lightless conditions *Chlamydomonas reinhardtii* employs negative gravitaxis—it swims against the pull of gravity. Algae, though, do not sense gravity and then adjust their swimming trajectory relative to the sensed property as they do in their light-directed swimming. Rather, their single-celled bodies are shaped and possibly weighted so as to "point up" when suspended in water (Roberts, 2006). Thus, in the absence of trajectory-altering light stimuli, *Chlamydomonas reinhardtii* typically swims toward the water's

surface. It is easy to see why being built to swim this way would be quite useful for an organism that relies upon photosynthesis for energy. At most locations on Earth, light comes from “above.” So, even if the current environment of the alga is dark, swimming up increases the likelihood of finding light if it is “up there” or being where the light will be when dawn comes.

During *Chlamydomonas reinhardtii*'s “default” gravitactic swimming, the flagella produce an asynchronous breaststroke-like pattern. The trans-flagellum beats at a roughly 30% higher frequency than the cis-flagellum (Hegemann & Berthold, 2009), but the cis-flagellum beats more forcefully (Isogai, Kamiya, & Yoshimura, 2000). The more forceful beating of the cis-flagellum causes the cell to spin counterclockwise around its anterior-posterior axis at a rate of around 2.6 hertz (twice per second) (Yoshimura & Kamiya, 2001). This rotation, though, occurs within a broader frame of motion. The unequal beating of the flagella also causes the cell to move through the water in a helical (corkscrew) pattern. The combination of this larger helical swimming path and the cell's counterclockwise rotation around its front-back axis results in the eyespot of *Chlamydomonas* always pointing “out” from the axis of the larger corkscrew path.<sup>76</sup> This allows the eye to constantly scan the environment for light as it swims (Foster & Smyth, 1980).

#### **4.2.2. Chlamydomonas and negative phototaxis**

A sharp, abrupt increase in light intensity (a “flash”) striking the algal eye produces one of two negative phototactic responses. 1) If the step-up in light intensity is relatively low, the cell stops its forward swimming. The flagella halt their asymmetric breaststroke pattern and switch to a synchronized undulating pattern, which drives the cell backward (for about 600 milliseconds). After this short move backward, the cell resumes its forward swimming. 2) If the step-up in intensity is relatively high, the cell produces a different response. It swims backward for the 600 milliseconds, but subsequently turns and swims away from the light rather than resuming its original course. In these cases, the

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<sup>76</sup> This describes cells that are identified as positively phototactic. Other variants of *Chlamydomonas reinhardtii* spin clockwise around their own axis when viewed from behind, which results in the cell's eye pointing toward the axis of its helical movement through the water. These cells are negatively phototactic. Their behavioral pattern with respect to phototactic turning is inverted relative to the positive phototactic turning I will describe later in the chapter.

undulating response is not completely symmetrical. The cis-flagellum produces 2-4 extra beats, which is enough to turn the cell away from the light such that when it resumes forward swimming, it is moving away from the light and potential injury (Hegemann, 2008; Ruffer & Nultsch, 1998).

The negative phototactic responses of *Chlamydomonas reinhardtii* are “all or nothing.” A steep step-up in light intensity either induces a photoshock response or it fails to (Josef, Saranak, & Foster, 2005). The flagella do not vary their beating in a manner proportionate to the intensity of light input. A very small change in the light stimulus does not produce a little bit of backward undulating or very slow undulating, and a slightly larger change in light does not produce faster undulating or faster backward undulating.

Given these features of *Chlamydomonas reinhardtii*'s negative phototaxis, someone holding a Sterelny-style view might naturally believe that the photophobic response of *Chlamydomonas reinhardtii* is not an instance of one Detection System, but two; two different light intensity ranges generate distinct adaptive photonegative responses. Or they might hold that there is a single behavioral response—avoiding light—that varies depending on the intensity of light. After all, nothing in Sterelny's view would imply that Detection Systems cannot adjust a feature-specific response to various dimensions of that feature or to the related stimulus that incites the behavior—say, have differential responses to different levels of illumination.<sup>77</sup> So, either way, it appears as though negative phototaxis is controlled by one or possibly two Detection Systems. However, once negative phototaxis is considered alongside positive phototaxis, it becomes evident that neither negative phototaxis nor positive phototaxis—nor the phototaxis of *Chlamydomonas reinhardtii* in general—can be coherently interpreted as implementing Detection Systems.

### **4.2.3. Chlamydomonas and positive phototaxis**

When *Chlamydomonas reinhardtii*'s eyespot is illuminated at sub-photoshock intensities, the cis-flagellum will beat less strongly relative to the trans-flagellum. If we imagine the cell swimming in its “default” helical path that we see during dark swimming, this change in flagellar beating causes the cell and its entire helical path to turn in the direction of the

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<sup>77</sup> Sterelny notes similar points (15-16).

light. Moreover, unlike in the case of negative phototaxis, the positive phototactic response is proportionate to the degree of stimulation received. Light striking the eye at a right angle to the plane of the anterior-posterior axis will produce the sharpest turn toward the light. Light striking the eye at any other angle will produce a smaller turn toward the light the further that angle is from normal.

Because light in earthly environments typically comes from one direction (from the sun) and the cell swims in a helical path with the eye always pointing outward, the eye is frequently exposed to light on only one side of this helical swimming path. So, during approximately half of a single cycle through the helical swimming path, the eye is unilluminated. While in the “dark phase” of its rotation, the cell returns to the “default” beating pattern we see during swimming that is exclusively gravity guided—the cis-flagellum is pulling stronger, and the trans-flagellum is beating more frequently. This “pulls” the cell back toward, but not back into, the path it was swimming before light struck. This is, of course, because the “pull” back toward the dark side can only pull the cell back to a path tangential to the curve of the turn just made, and not back to the path it was on before making a turn. As the eye returns to the illuminated side of its helical swimming path, it is once again struck by light, and it again turns toward the light. And then, once again, when the eye turns to the dark side of the helix, the cell “pulls back” to a trajectory tangential to the curve of the turn just made. It is almost as if there were a tug of war between the dark side and the light side of the helical swimming path, in which the light side gains the advantage on each rotation, even though the “pull” toward the light is weaker on each successive turn.

This “back and forth” between the light and dark sides of the cell’s rotation continues until the cell has turned the axis of its helical swimming path (and so its own posterior-anterior axis), parallel to the direction of the light’s propagation (i.e., the cell points toward the point of average highest intensity—usually, therefore, toward the light source). Once this is achieved, both (technically all) sides of the helical path are illuminated.<sup>78</sup> So, on both sides of the helical swimming path and the cell’s rotation around its front-back axis, the cell’s eye is struck by light at a very sharp angle (relative

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<sup>78</sup> I will use “both sides” for simplifying the description. *Chlamydomonas* cannot respond to illumination on all sides throughout its rotation; the photoreceptors of the algal eye have to recover after being stimulated illumination—about the time it takes to make half a rotation around the alga’s axis—and so cannot continuously adjust the flagellar beating pattern.

to the plane of the posterior-anterior axis). Consequently, the cell will make, on one side of its rotation, a small turn away from a parallel-to-light orientation, and then on the other side of its rotation will make a complementary small turn in the other direction. By making these sets of opposing turns away from a trajectory parallel to the direction of the light's propagation, the cell maintains a net parallel orientation to that line of propagation and thus swims more or less straight ahead into the light of increasing intensity. (For more on the general positive phototactic picture of *Chlamydomonas* swimming presented in this and the previous paragraph, see Foster & Smyth, 1980; Hegemann & Berthold, 2009; Isogai, Kamiya, & Yoshimura, 2000).<sup>79</sup>

### 4.3. Putting the positive and the negative together for *Chlamydomonas*

The problem for a Detection System interpretation of *Chlamydomonas*' negative and positive phototaxis might not be completely obvious on the basis of juxtaposition, so I will draw the difficulty out. In the first place, both positive and negative phototaxis in *Chlamydomonas reinhardtii* are directed at the same feature of the environment—typically the sun (or a laboratory substitution). An organism that implements a Detection System with respect to some feature of the world is only supposed to be able to implement one adaptive response relative to that feature. Here, however, there are two adaptive responses relative to a single feature of the environment.

One could try to resist this point by holding that it is more reasonable to hold that the environmental signal—light of a given intensity range—and the feature of the environment to which the Detection System aims its response are one and the same. So, light of low intensity is both the target feature of, and the signal that stimulates, positive phototaxis; high intensity light is the target and sensory trigger of negative phototaxis. I think it is ambiguous what the feature is that *Chlamydomonas reinhardtii*'s

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<sup>79</sup> A direct implication of this design is that that if *Chlamydomonas reinhardtii* were illuminated to virtually the same degree on both sides of its rotation around the helical axis, we would not see a change in the net swimming direction of the cell. A corollary of this discussion is that if there were more than one diffuse light source in the environment, the cell would not orient toward the brightest one. Rather, it would “average” over the inputs and so would chart a path between them—closer to the brightest, but not directly toward it. However, typically, the natural environment of *Chlamydomonas* will have a single light source—the sun. So, typically, *Chlamydomonas* orients toward a single light source. See also Matsunaga, Watanabe, Sakaushi, Miyamura, & Hori (2007); Schaller & Uhl (1997).

behavior is aimed at—it could plausibly be interpreted as the sun (or other light source) or the light itself, as either will allow us to explain the phototactic behavior of the alga. So, this point can be granted, but it does not help someone who thinks that the behavior of organisms like *Chlamydomonas reinhardtii* is either signal- or feature-specific. This fact becomes evident once we know that organisms like *Chlamydomonas reinhardtii* become light-adapted and dark-adapted—the behavioral sensitivity of the organism's responses to light increases the longer it is in the dark and decreases the longer it is exposed to light. In the case of negative phototaxis, if the cell has spent a long time in an unilluminated environment, the step-up in light needed to evoke the first photonegative response (backing up briefly before resuming forward swimming) can be quite small. Triggering the second photonegative response (backing up, turning, and swimming away from the light) in a dark-adapted cell will require a larger step-up in intensity than that required to initiate the first. However, in the case of a light-adapted cell, a step-up in intensity sufficient to stimulate the second photonegative response in a dark-adapted cell may be insufficient to stimulate either response, or be only sufficient to stimulate the first photophobic response.<sup>80</sup> Moreover, light stimulus that fails to elicit either photonegative response in a light-adapted cell will often stimulate positive phototaxis. Similarly, light that is sufficiently intense to evoke the second photonegative response in a moderately or even strongly light-adapted cell will perpetuate a photophilic response in cells that have been swimming into the light for a sustained period. As the cell continues to swim toward the light source or point of average highest intensity, the intensity of the light stimulus increases, as does the light adaptedness of the cell, to the point where only very intense light will produce any phototactic response. (For more on the features of *Chlamydomonas*' light adaptation, see Govorunova, Sineshchekov, & Hegemann, 1997; Hegemann, Ehlenbeck, & Gradmann, 2005; Sineshchekov, Jung, & Spudich, 2002.)

So, no matter how we distinguish the environmental signal and the environmental features to which *Chlamydomonas reinhardtii* produces positive and negative phototaxis, we have two different adaptive behavioral responses produced with respect to the same feature or signal of the environment. The phototaxis of this alga is, therefore, not organized or produced by a Detection System or similar highly specialized, inflexible,

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<sup>80</sup> Of course, sufficiently large steps up in intensity will produce the second photophobic response in both light and dark-adapted cells.



behavioral system.<sup>81</sup> To understand what kind of behavioral organization *Chlamydomonas reinhardtii* does have, it will be helpful to look at the alga's phototactic behavior in its natural environment.

#### 4.3.1. *Chlamydomonas* phototaxis properly situated

I have to admit, at this point, that the discussion concerning *Chlamydomonas reinhardtii*'s phototaxis so far has been somewhat artificial and does not entirely reflect the alga's light-guided movement as it manifests in its natural environments. Smooth negative and positive phototaxis are observed only under constant, low light conditions, which are found almost exclusively in laboratories (Hegemann & Berthold, 2009). The light moving into and through bodies of water outside the lab is continuously shifting; both the direction and intensity of the light will change as the water shifts and swirls. The erratic movement of the water not only randomizes the light's trajectory and intensity, but will also push the algae toward darker water or too far into the light, potentially disrupting whatever orientational response is underway at the time.

In such circumstances, *Chlamydomonas reinhardtii* rarely has the opportunity to perform an entire positive orientation cycle or an entire cycle of negative phototaxis type 2 (backing up while turning and then swimming away from the light). The cell's movement *in situ* will largely consist of turns toward the light interrupted by the movement of the water, or of sudden shifts causing the simplest "back-up" photoshock response without any smooth and continuous orientation toward or away from the light. Visualized, the phototactic behavior of *Chlamydomonas reinhardtii* in its natural environment will look very much like a random walk resulting in net positive phototactic movement.

By continuously adjusting its trajectory away from light that is too intense and toward light that is not too intense, *Chlamydomonas reinhardtii* effectively finds a balance (a trade-off point) between meeting two light-relative needs—avoiding potentially fatal radiation damage and absorbing sufficient light to maintain metabolism, etc.

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<sup>81</sup> On Sterelny's basic evolutionary story, the ability to produce two different behaviors with respect to the same environmental signal (and feature of the world) is somewhat "farther along" the development of agency than the Detection System—it is somewhere in the zone where signals and behaviors are becoming "decoupled" and we are on the path to full-blown "decoupled" representations and intentional agency of the familiar human sort (p. 34-34).

*Chlamydomonas*' phototactic behavior, therefore, can be readily conceptualized as a continual adjustment of its swimming toward an environmental “sweet spot”—or “best overall position”—where light can be safely absorbed.

The continuous adjustment of the alga's swimming toward a best overall position for safe light absorption generalizes to other features of the environment and to environmental signals for organisms like *Chlamydomonas*. In the first place, *Chlamydomonas reinhardtii*'s positive phototaxis is enhanced by kairomones<sup>82</sup> released into their environments by predators like *Daphnia pulex* (who we will meet below). This causes the algae to clump together near the surface of their freshwater environments, which makes it harder for filter feeding predators like *Daphnia* to swim through the space that the algae are occupying and so eat them (Lurling & Beekman, 2006). Moreover, other organisms similar to *Chlamydomonas reinhardtii*—phytoplanktonic flagellates—respond with positive and negative taxis (directed movement) to temperature as well as to various chemical elements of their environments such as phosphates, oxygen, carbon dioxide, and pH levels. They balance these concerns against each other during orientation toward various optimums or “best overall” places to be, relative to the strength and metabolic (survival-relative) import of these stimuli (M. R. Clegg, Maberly, & Jones, 2003, 2004; Mark R. Clegg, Maberly, & Jones, 2003).<sup>83</sup>

Generally speaking, then, organisms like *Chlamydomonas* adapt to their environments by swimming toward many stimuli relevant to survival or self-maintenance, and swim away from other survival-relevant stimuli, sometimes swimming toward and away from the very same stimuli. Such an organism, therefore, does not implement modular behavioral units that produce a behavior exclusively suited (or evolutionarily designed) for a single feature of the world or for a single environmental signal. Rather, the elementary, adaptive motile behavior of *Chlamydomonas reinhardtii* and other similar single-celled organisms utilizes multiple and often conflicting metabolic or life-sustaining stimuli to modify a continuous, orientational behavior toward a “best overall” place to be.

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<sup>82</sup> Kairomones are chemicals released into the environment by one species of organism that benefit the members of another species (without benefiting the producer).

<sup>83</sup> Similar findings have been reported for bacteria like *E. coli* as well (Alon, Surette, Barkai, & Leibler, 1999; Demir & Salman, 2012; Levit & Stock, 1999).

## 4.4. *Daphnia pulex* and single feature-specialized behavior

This multi-purpose orientational behavior is not restricted to organisms like *Chlamydomonas reinhardtii*; it effectively “scales up,” generalizing to relatively simple animals like the tiny (0.2-3 mm in length) crustacean *Daphnia pulex*. It might not be surprising that they and *Chlamydomonas* live in similar freshwater environments (indeed, *Daphnia* eat *Chlamydomonas*), and both exhibit substantive negative and positive phototaxis.

*Daphnia pulex*,<sup>84</sup> as a model organism,<sup>85</sup> has been extensively studied with respect to a phototactic behavioral pattern known as diel vertical migration. As the sun rises, the proportion of blue wavelengths increases along with the overall intensity of the light striking the surface of a body of water. *Daphnia* responds to the increasing proportion of blue wavelengths and increasing light intensity by moving away from the surface toward darker waters below. When the sun begins to set, the proportion of red wavelengths striking the water increases, while the intensity of the light striking the water decreases. The receding redder light leads *Daphnia* back up toward the water’s surface. *Daphnia*’s daily migration is thought to have been preserved by evolution because it allows the crustacean to avoid visually hunting predators such as juvenile fish that populate the water’s surface during the day, and then return to the surface, where food is plentiful, at dusk and night.

*Daphnia* discriminates the day’s blue light and the dusk’s red light via a single compound eye, which is located in the center of the crustacean’s “face.” The eye also enables *Daphnia* to discriminate light intensity, polarization, and UV concentration. However, despite having a compound eye consisting of a number of cylindrical ommatidia (the “individual eyes” of a compound eye) with their own lenses and photoreceptors, *Daphnia* has almost no spatial acuity. This is because the lenses at the “top” or “front” of each ommatidium focus the incoming “image” formed by the light well behind the photoreceptors clustered at the base of each conical unit. The photoreceptors “block”

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<sup>84</sup> Again, see Pollon and Akins (2014) for an earlier use of *Daphnia* to establish difficulties for the Detection System concept. See also Akins and Hahn (2014) for a discussion of *Daphnia*’s visual systems and their import for understanding color vision.

<sup>85</sup> *Daphnia pulex* serve as a model organism for various purposes; see Altshuler et al. (2011); Harris, Bartlett, and Lloyd (2012).

this image from being formed, and so the light that strikes them is unfocused. So, while *Daphnia* has much more complex sensory machinery than *Chlamydomonas*, it's only able to use it for similar basic directional guidance—it swims toward light or swims away from light (with the caveat that it is able to use more than just intensity information to determine whether to move toward or away from the light) (Leech & Williamson, 2001; K. C. Smith & Macagno, 1990; Young & Downing, 1976).

*Daphnia*'s swimming in response to light (and otherwise) is accomplished by modulating the frequency and strength of a “stiff-armed” breaststroke executed by the large (approximately half the length of the crustacean's whole body) secondary antennae located on each side of the its head.<sup>86</sup> This movement by stiff-armed breaststrokes makes it appear as though *Daphnia* is hopping through the water rather like the land-dwelling fleas that are so often found on our pets. Unlike the land flea, though, the “water flea” has no ground to land upon when it hops. So, after it hops, it sinks. Daphnid swimming, therefore, consists almost entirely of hopping and sinking at either long or short intervals. Longer intervals between hops usually result in a controlled descent or depth maintenance, while shorter intervals result in moving forward. Moving forward is often moving toward the surface, but *Daphnia* can swim in most directions, as the trajectory of the hop is dependent upon the direction the water flea's head is pointing at the beginning of and throughout the hop.

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<sup>86</sup> To place the antennal propulsion system in anatomical context: If one were to draw a schematic of *Daphnia pulex*, one would capture the basic shape of the crustacean by laying down the outline of a legless, squat, cartoonish bird possessed of a large, puffed out chest and belly with a rounded or hunched back. Once this basic outline is laid down, only a few modifications are needed to complete the picture. The crustacean's mandibles should already be present, as they have, in profile, the appearance of a short, hooked beak. Above and to the rear of the mandibles is where one should lay in the base of the antenna, which looks similar to a tree limb with its branches cast downward, pointing out in front of the daphnid's head. (This is not unlike how one would draw a human body in profile with an arm raised level with the shoulder and pointing forward.) In profile, only one antenna is needed, the assumption of bilateral symmetry leaving the second antenna implied. Finally, to complete the image, break the line that curves from the belly toward the back just as it meets the daphnid's “spine.” Then add into the break a thin, pointed, back curving tail. Such an illustration provides a relatively accurate representation of the external anatomy. But if one were a stickler for full veracity with respect to *Daphnia*'s appearance, one would now go on and draw in the internal organs of the animal in the side view, as its body is typically transparent or translucent, and so can be seen from outside the organism's walls. However, for the purposes of this discussion, the only organ that can be seen through the shell in profile that needs to be added is the compound eye, which appears as a cluster of dark spots in the forehead above the plane of the antennae's base. (*Daphnia* also possesses a small “pinhole” eye below the much larger compound eye, which in profile, is obscured by the antenna. Little is known about the function of this organ).

Red light, then, prompts *Daphnia* to produce a sustained series of small hops toward the surface of the water, where it will continue to hop at (more or less) regular intervals to maintain its position. In blue light conditions, *Daphnia*'s antennae will beat infrequently, allowing the crustacean to sink to a safe depth where it will, again, maintain its position by various intermittent hops until it is safe to head to the surface again, i.e., when the light coming from the surface is mostly red.

At first glance, *Daphnia*'s diel vertical migration looks a lot like the implementation of a pair of opposing Detection Systems, similar to how the negative and positive phototaxis of *Chlamydomonas reinhardtii* first appears. The main difference would be that diel migration is carried out by more complex and sophisticated mechanisms than those seen in *Chlamydomonas*. This difference could seem promising to someone wanting to retain a Sterelny-style view. Complications arise for the application of the Detection System model in the case of *Chlamydomonas* because the same signals can prompt both the positive phototactic and the negative phototactic responses. The greater sophistication of *Daphnia*'s sensory systems enables two clear signals—red light and blue light—to each trigger its own behavioral response—swimming up and down, respectively. So, one might think that a case could be made that organisms like *Chlamydomonas* are too simple to implement Detection Systems. We need to look “higher up” the phylogenetic tree to find them—to get clearly distinct pairings of signals and behavioral responses. If this idea works out, we would still keep Detection Systems restricted to pretty simple organisms and still have a plausible evolutionary story about the origins of our kind of intentional agency from Detection Systems. We would just have to accept that Detection Systems, and so the evolutionarily foundational type of agency, do not extend all the way down to single-celled organisms. This is not, in itself, a problem. Nothing requires that the most elementary agency be found among single-celled organisms. Sterelny acknowledges that there will be behavioral control in organisms that is even more rudimentary than that to be found in Detection System (p. 11-12). Furthermore, Sterelny, and most other people trying to develop accounts of Biologically Basic Agency, is looking for the agency that precedes or backgrounds human agency. So, if agency begins in simple animals, the evolutionary account might be easier to run since it would not have to cover or account for lineages that fall outside the animal kingdom.

#### 4.4.1. Diel migration in *Daphnia* does not implement a feature- or signal-specialized behavioral system

The other shoe, as one might expect, must drop. If we look more closely at the orientational behavior of *Daphnia*, we find that such an interpretation is unsustainable (as it was in the case of *Chlamydomonas*). Sinking away from the surface and swimming up to the surface in *Daphnia* are behavioral responses that can and do depend upon a number of different environmental signals that correlate with various features of the environment.

In the first place, sinking away from the surface is also partly driven by the presence of kairomones exuded by the visually hunting juvenile fish (Ringelberg, 1999; Van Gool & Ringelberg, 1998). So, sinking away from the surface is driven by more than one environmental signal. And therefore, the behavior is not tied to a single environmental signal. Though one might want to point out that both signals drive a specific, predator avoidance behavior. So, at a minimum here, we would still have feature-specialized behavior, even if it is not locked to a single environmental signal. One might also try to make the same point for *Daphnia*'s move to the surface at dusk where food is to be found. *Daphnia* does not only respond to red light. It also uses the chemical traces left in the water by its single-celled food to guide movement toward the surface where it will filter feed much like a baleen whale by swimming through patches of phytoplankton in various patterns.<sup>87</sup> So, here we may also have a feature-specialized behavior even though we do not have an environmental signal-specialized behavior.<sup>88</sup>

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<sup>87</sup> If the crustacean is starving and food is plentiful at the surface, you will likely find daphnids closer to the surface despite a high risk of predation. One does not gain much by dying of starvation to avoid predation (Kessler & Lampert, 2004). Indeed, internal states or signals like caloric debt (hunger) also have an influence on how strongly some stimuli—like food concentration—affect the utopic orientation of organisms like *Daphnia* (Dini & Carpenter, 1992). *Daphnia* responds in diverse ways to food concentration given its physiological situation. The smaller the daphnid and the lower the food concentration, the less the daphnid sinks away from the surface (Johnson & Jakobson, 1987). The less able the organism is to stave off the effects of food deprivation, the less able it is to dive as deeply as needed to avoid surface predation. So, we could, and should, also readily count various internal signals and states regarding the “internal” environment of an organism as substantive contributors to finding the best overall place to be in its environment.

<sup>88</sup> Behavioral systems that use more than one environmental signal to generate a feature-specific adaptive response are called “Robust Tracking Systems” by Sterelny. They are to constitute the first step away from Detection Systems in the evolution of agency. Importantly, they are still, like

However, the attempt to shift to a feature-specialized interpretation (rather than feature- and signal-specialized interpretation) of the components of *Daphnia*'s diel vertical migration is unworkable. Daytime hunting by juvenile fish are only a risk to *Daphnia* for a little over 6-7 weeks. When the juvenile fish have grown and are no longer hunting *Daphnia*, diel vertical migration continues, though depth changes are smaller (Dini & Carpenter, 1992; Lampert, McCauley, & Manly, 2005; Van Gool & Ringelberg, 1998; Winder, Spaak, & Mooij, 2004). Moving away from the surface during the day persists beyond the threat of predatory juvenile fish because UV light, most prevalent at the water's surface during the day, is also a hazard for *Daphnia*. As the sun moves toward its ascendant position, not only does the proportion of both blue light and light intensity increase at the surface, so too does the amount of UV light. So, moving deeper into the water, where the sun's light is better filtered, also protects *Daphnia* from light damage caused by UV radiation. One might, perhaps, suspect that this UV light avoidance merely piggybacks on the registration of the correlating increase in blue light and overall light intensity. But this is not so; *Daphnia*'s eye, as noted above, discriminates UV light concentration.<sup>89</sup>

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Detection Systems, locked to a single feature of the environment—the advance they offer is simply that they use more than one signal to “trigger” the behavioral response (p. 27-29). I raise this point here because one might think that Sterelny's basic position could be modified to simply start with feature-specific behavioral modules, rather than feature-specific behavioral modules that use only one signal to release the behavior they control. As we will see in the main text, holding that the simplest agents will be “feature-specific,” rather than strictly “Detection Systems” doesn't get one much further.

<sup>89</sup> *Daphnia* has a further adaptation to UV light—like many humans, daphnids tan. If exposed to high UV, their shells begin to turn brown and translucent rather than transparent in order to stop UV light from passing through their carapace to the organs, etc. housed within (Hansson, Hylander, & Sommaruga, 2007). Tanned daphnids tend to sink less deeply during the daylight hours than their paler fellows. *Chaoborus* kairomones also induce a “passive” defense. *Daphnia* develops “neck teeth”—spiny protrusions around where the crustacean's head meets its body—during the third instar (period between molts—cuticle shedding), which make it uncomfortable for the midge fly larvae to eat them. This also tends to allow some *Daphnia* to sink lower in the water relative to their conspecifics that have not developed neck teeth (Hammill, Rogers, & Beckerman, 2008; Havel & Dodson, 1984; Imai, Naraki, Tochinai, & Miura, 2009). Inducible defenses like this explain, in part, why there is a stratification of the *Daphnia* population in lakes—why some are closer to the surface during the day and some are deeper down while some are in the middle. Of course, natural variation in a population with respect to sensitivity and responsiveness to stimuli will contribute to variation along with whether or not other phenotypic defenses against predators and UV radiation have been induced.

#### 4.4.2. *Daphnia*'s relationship with deeper, darker water and other elements of their environment

Sinking away from daylight might, then, seem like an ideal strategy for managing UV light exposure and avoiding predation, but this is not a simple problem to solve. *Daphnia* has predators in the deeper, colder water such as *Chaoborus* larvae (a species of midge fly). So, it would not be ideal to avoid UV damage only to be eaten. *Daphnia* has also evolved sensitivity to chemicals (kairomones) exuded by these deeper water predators. These kairomones drive *Daphnia* back toward the surface. But, as we know, swimming all the way up to the surface is not a good idea because of the high UV light concentration. Therefore, *Daphnia* tends to find a best “overall” depth—one that decreases the risk of predation while decreasing the likelihood of UV damage, but also one that does not eliminate either danger entirely (Boeing, Leech, Williamson, Cooke, & Torres, 2004).

Similar points play out for a number of other features of *Daphnia*'s environment. Even if the threat of predation from below is absent, moving deeper into the water to avoid UV exposure or predation from above is not without risk. The deeper, darker water is colder water, and the local temperature is not a matter of indifference for *Daphnia*. The warmer water near the surface provides the best conditions for growth and metabolic function. But, of course, this is where the predatory fish and harmful UV light are. So, *Daphnia* cannot stay in the metabolically kind water near the surface during peak daylight hours. But if *Daphnia* sinks toward and stays in water that is too cold for too long, metabolic processes slow and stop, and death follows. Further, the more time *Daphnia* spends in colder water, the poorer and slower its development. *Daphnia* that mature primarily in colder water tend to be smaller than their peers who came of age in warmer waters. So, there are reasons to avoid the colder water, even if death is not an immediate threat (Kessler & Lampert, 2004; Lampert et al., 2005; Ringelberg, 1999). Given the importance of temperature to *Daphnia*'s survival and thriving, it is not surprising that varying water temperature is a stimulus utilized by *Daphnia* to determine how close to the surface it ought to be at a given point in time. Nor is it surprising that *Daphnia*'s response to this stimulus must also be balanced with stimuli driving it toward the colder water—like predator kairomones, blue light, high intensity light, and UV light.



I think it is clear that at any given time there are some survival-relevant environmental concerns “pushing” *Daphnia* toward the surface (water temperature, food concentration, insect larvae kairomones, increasing red light, and decreasing light intensity) and several concerns pushing *Daphnia* away from the surface (juvenile fish kairomones, increasing blue light, increasing light intensity, and high UV light concentration). *Daphnia* must therefore occupy a depth that balances these various concerns in such a manner that it avoids as much danger as possible while staying fed and enabling its metabolic processes to continue. Indeed, this is what is observed: *Daphnia* adopts an ideal distribution of costs throughout a water column (Fiksen, 1997; Lampert et al., 2005).<sup>90</sup>

#### **4.4.3. *Daphnia*’s orientational behavior is very similar to *Chlamydomonas*’ in basic organization despite its greater complexity**

In a manner similar to that of *Chlamydomonas reinhardtii* (see Section 4.3.1), *Daphnia* utilizes a continuously produced single behavioral kind—swimming via “hopping” and sinking—to continuously adjust its position (up and down<sup>91</sup>) in the environment in response to a number of different sensory stimuli that correlate with different features of the environment and are important to the organism’s self-maintenance and survival. This orientation process is continuous because *Daphnia*, like *Chlamydomonas*, is always suspended in water, and if it were to stop swimming it would sink into uninhabitable waters. Further, the various features to which *Daphnia* is sensitive change more or less continuously. The temperature of the water at various depths changes throughout the day, as does the location of food concentrations; predator kairomone concentration might change, and the intensity, color, and UV content of light changes as well. So *Daphnia*, like *Chlamydomonas*, is continuously orienting toward a continuously changing “best overall” position in its environment relative to a number of continuously changing environmental factors important to its self-maintenance and survival. However, as in the case of *Chlamydomonas*, it is unlikely that *Daphnia* would ever be able to achieve an absolute “best position overall.” This is because, in addition to the continuously changing

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<sup>90</sup> *Daphnia* that are larger and can stand colder water tend to be lower in the water than those that are smaller and cannot. *Daphnia* that are tanned can avoid colder water and insect larvae predation better by floating closer to the water’s surface because UV light is a lower risk for them than it is for their untanned fellows.

<sup>91</sup> As well as other directions.

features of the environment to which they both respond, *Chlamydomonas* and *Daphnia* live in bodies of water, and so their small bodies are always being pushed about by shifting currents, etc.<sup>92 93</sup>

## 4.5. Conclusions

The highly intuitive notion—embedded in Sterelny’s (2003) conception of the Detection System—that the simplest sorts of behavioral systems that will give rise to our own agency will be feature- or signal-specialized (single stimulus “locked”) cannot be maintained. If we examine the behavior of very simple model organisms—single-celled organisms like *Chlamydomonas reinhardtii* and very small animals like *Daphnia pulex*—it is evident that the bulk of their adaptive behavior is not controlled in this way. Rather, when we look to model the behavior of these organisms as single feature or signal locked, we find that very simple motile organisms modify continuous orientational behavior like swimming relative to a number of survival or self-maintenance relevant features of their environments toward a “best overall” position in these environments that balances the various and often competing concerns. I call such behavior Utopic—organisms move toward a “good place” in their environment, given various

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<sup>92</sup> One might want to say that *Daphnia* is searching for a spot in the environment that maintains homeostasis. However, while that may be true with respect to moving toward warmer water and away from colder water, and moving toward and through food, it does not really capture movement in response to kairomones or UV light, blue light, or intense light since the correlating features of the environment don’t directly affect homeostasis but are rather determinants of whether homeostasis can occur or not. Predator avoidance is not obviously related to maintaining homeostasis, but one does need to avoid predation to have the opportunity to maintain homeostasis.

<sup>93</sup> One could, I think, wonder a bit at why, in this chapter, I have focused on behavior like diel vertical migration of crustaceans and the phototaxis of algae. After all, the basic behavioral context of organisms is that they are continuously adjusting their behavior in various ways relative to multiple features of the environment and their internal states. This fact itself might appear to impugn a Detection System style picture of the simplest agency. But it would be entirely coherent to hold that Detection Systems emerge from this baseline biological situation. Sterelny grants that there are other more basic adjustments organisms can make to their environment. And so he thinks agency *starts* with feature-specialized behavior—not that there is no such thing, even among simple organisms, as generalized behavioral strategies. So, it needs to be shown that behavior that could be most readily thought of as the best sorts of candidates—those that intuitively or without much investigation appear to exhibit or implement Detection Systems—really probably do not. And that is what I have done here by examining behavior that really does, given a brief description of the behavior, look like instances of Detection Systems but is not. And because this has been shown in model organisms, it is very unlikely that feature-specialized behavioral systems are common or typical to other single-celled organisms.

environmental concerns, but the ideal location can never be found because of the constantly shifting nature of their environments, and so they also search for “no place.”<sup>94</sup>

These findings, along with the findings of Chapter 3 regarding the widespread ethological rejection of the idea that single feature-specialized “inflexible” behavioral routines are typical of animals, make it extremely unlikely that feature-specialized behavioral modules are common or typical in the organic kingdom. This, in turn, makes it highly unlikely that the kind of agency that we have emerged as a matter of increasing flexibility from inflexible behavioral systems. Organisms at the “lowest levels” utilize flexible orientational behavioral types—like swimming—to respond adaptively to multiple features of the environment at a given time. Our agency, therefore, emerges within a context of flexible behavior that is generalist—used to meet multiple, divergent needs.<sup>95</sup> Consequently, the modification of continuous orientational behavior relative to a number of survival or self-maintenance relevant features of the environment toward a “best overall place to be” relative to those features—which I have dubbed Utopic Behavior—is an obvious and promising account of Biologically Basic Agency.

In the next chapter, I take up the task of developing and justifying the position that Utopic Behavior will provide a plausible and promising account of Biologically Basic Agency. I will do this by showing that a Utopic Behavioral conception of Biologically Basic Agency will meet all of the guidelines and constraints on accounts of Biologically Basic Agency that I have established in Chapters 1 through 3.

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<sup>94</sup> I know, technically, “eutopia” is “good place.” But if the pun was good enough for Thomas Moore, it is good enough for me.

<sup>95</sup> Because of this, I think that the basic story regarding the development of agency in the organic world runs counter to what is deeply intuitive to many. Agency, of simpler and more sophisticated kinds, is a matter of increasing behavioral specialization that emerges from or within the context of generalized behavior rather than generalized behavioral capacities arising from specialized ones.

## Chapter 5.

### Utopic Behavior

#### 5.1. Introduction

In Chapter 4, I established that the simplest agency to be found among organisms cannot be credibly understood as an “inflexible” behavioral type that produces a single behavioral response in the presence of a single feature of the environment, despite the deep intuitive appeal of such a view. To demonstrate this, I applied a restricted version of Kim Sterelny’s (2003) conception of the simplest agency as an inflexible, feature-specialized behavior—the Detection System<sup>96</sup>—to the behaviors of two simple model organisms—*Chlamydomonas reinhardtii* (a motile green alga) and *Daphnia pulex* (a tiny crustacean)—that, at first blush, might be obvious cases of single-purpose behavioral responses. Once these behaviors—phototactic swimming of *Chlamydomonas* and the diel vertical migration of *Daphnia*—were investigated in detail, it became apparent that such behavior in these organisms could not be accurately described as producing feature-specialized behavioral responses. Instead, organisms like *Daphnia* and *Chlamydomonas* adaptively orient in their environments by utilizing multiple sensory or informational inputs. These inputs correlate with multiple features of the world important to survival and metabolism maintenance and allow the organisms to orient (swim) toward a “best overall” position in the environment relative to these various features. Such orientation behavior enables these organisms to balance multiple vital needs concurrently—to safely maintain themselves or sustain metabolism without (excessive) sacrifice of resources or (over) exposing themselves to harm—by modulating a single behavioral type. I dubbed such behavior Utopic. It should be noted here that organisms generally have this feature, i.e., the adjusting of behavior (motile or otherwise) relative to a number of concerns, features, and signals in the environment, including those of an

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<sup>96</sup> In the last chapter, I used a version of Sterelny’s Detection System concept that was to only be applicable in the case of very simple organisms. I did this on the basis of arguments in Chapter 3, which, in part, established that the detection was applied too broadly to play the role Sterelny wanted it to play in the kind of evolutionary story he wanted to tell.

organism's internal environment such as calorie debt, where one is in one's circadian rhythm, etc.

Given the results of Chapter 4, Utopic Behavior seems like a natural and obvious candidate for an account of Biologically Basic Agency. Consequently, in this chapter I will defend its plausibility as an account of Biologically Basic Agency. I will do this by showing that Utopic Behavior meets the conditions of adequacy for accounts of Biologically Basic Agency established in Chapters 1, 2, and 3.

Recall that the conditions of adequacy are:

1. That an account of Biologically Basic Agency be formulated in representation-neutral terms (Chapter 1).
2. That Biologically Basic Agency identifies a behavioral type that is "Goal-Directed Motor behavior/movement" consistent with Modern Action Theory (Chapter 1).
3. That Biologically Basic Agency be a distinctive subset of the class of behavior—i.e., not all behavior is action (Chapter 1).
4. That the account of Biologically Basic Agency can be rejected or falsified on the basis of empirical findings regarding the behavior of organisms (Chapter 2).
5. That an analysis of Biologically Basic Agency fit a standard classification scheme for biological traits. There are two broad classification options here (Chapter 1 and modified in Chapter 3):
  - a. The first is to offer a viable Strong Evolutionary story, one that identifies a common ancestor agent from which all later agents have descended (and so one possesses agency in virtue of inheriting that trait from a single common ancestor).
  - b. The second approach is to identify a broad functional category that has evolved in various lineages in various ways because it is a Good Trick or useful thing to do in virtue of being a living organism and having the needs that living organisms often do. Such an account, though, does not presume a common ancestor from which all instances of the biological trait have evolved (as in a Common Ancestor variety a Strong Evolutionary Story). Nor does it presume that there is a uniform set of evolutionary stages that all instances of the type will have followed from a simplest (independently evolved) version of the type (as in a Common

Trajectory Strong Evolutionary story). Biological traits like camouflage, heterotrophy, and autotrophy constitute examples of this sort of biological classification scheme.

Demonstrating that Utopic Behavior meets all of these conditions will establish that Utopic Behavior provides a better account of Biologically Basic Agency than those of Kim Sterelny (2003) and Tyler Burge (2009, 2010) discussed in Chapters 2 to 4, since neither of those views can meet all of the identified adequacy conditions. Burge's account fails most notably with respect to conditions 3 and 4, while Sterelny's account fails with respect to condition 5. Meeting all of these conditions and so offering a better account than either those of Burge or Sterelny establishes, I think, a basic plausibility for Utopic Behavior as an account of Biologically Basic Agency. Moreover, since the primary motivation in offering an account of Biologically Basic Agency is to situate human agency within a broader biological context by establishing a continuity of biological type with the agency of other organisms, the strongest test of an account of Biologically Basic Agency is how well a proposed account can establish and support such a continuity. I believe that Utopic Behavior, in addition to meeting the identified conditions of adequacy, can make strong claims to establishing the continuity between human agency and that of other organisms identified by the theory.

The first part of this chapter will consist of showing that an account of Biologically Basic Agency as Utopic Behavior meets all five adequacy conditions, and the second will consist of establishing the appropriate continuity for human agency. In the first part, I will show that Utopic Behavior provides a representation-neutral description of action. I will also demonstrate the claim that Utopic Behavior is Biologically Basic Agency is empirically testable in the appropriate ways. This discussion will also allow me to show that there are differing expectations regarding what we should observe depending on whether one's account of Biologically Basic Agency identifies a Common Ancestor biological category or a Good Trick category. In doing so, it will become evident that Utopic Behavior cannot offer a Common Ancestor categorization but does offer a plausible Good Trick biological categorization of behavioral types. Once adequacy conditions 1, 4, and 5 have been met, it is fairly straightforward to show that Utopic Behavior describes a kind of goal-directed movement found amongst a variety of organisms. However, despite this, it is not obvious how Utopic Behavior is to be

distinguished as a subclass of behavior in virtue of simply describing a goal-directed type of movement—in other words, how can it generate a class of behavior that makes it such that not all behavior is action? After all, all behavior by organisms could be reasonably seen as a kind of goal-directed movement. So, some properties or features of Utopic Behavior need to be identified that separate it out from behavior generally, that are not common to all behavioral types. The difference maker will be that Utopic Behavior inherently involves movement around one's environment—not just movement—which affords those organisms that exhibit Utopic Behavior behavioral options not made available by other behavioral types.

Despite Utopic Behavior identifying a subclass of behavior and its meeting the remaining four adequacy conditions, one could reasonably suspect that Utopic Behavior, as an account of action inherently involving movement around one's environment, is *ad hoc*. Why think it has not been chosen simply because it happens to meet the identified adequacy conditions? To address such concerns, I will appeal to the foundational motivations for developing an account of Biologically Basic Agency like that defended here, which is to situate human agency within a broader and deeper biological type or types of agency. The strength of an account of Biologically Basic Agency, once it has met the identified adequacy conditions, will depend upon how well it can establish a continuity between human agency and the other agencies identified by the account on offer. And Utopic Behavior does a good job of this. The prototypical cases of human action focused upon in Modern Action Theory—goal-directed motor behavior or motor action (which are relied on to generate a number of the adequacy conditions listed above—see Chapter 1)—are readily shown to be instances of Utopic Behavior. So, human motor actions possess the same properties or features that the proposed actions of organisms like *Chlamydomonas* and *Daphnia* possess. Therefore, Utopic Behavior identifies a behavioral type that admits of a Good Trick biological categorization and demonstrates a continuity of action and agency deeply and broadly within the phylogenetic tree.

## **5.2. Utopic Behavior is a representation-neutral account of Biologically Basic Agency**

Fairly straightforwardly, Utopic Behavior as a conception of Biologically Basic Agency is representation-neutral. My description of the behavior of *Daphnia* and *Chlamydomonas*

as Utopic Behavioral systems in the last chapter and at the beginning of this chapter do not describe them in terms that either require or deny that representational states of some kind are involved. *Daphnia* utilizes a continuously produced single behavioral kind—swimming via “hopping” and sinking—to continuously adjust its position (up and down<sup>97</sup>) in the environment in response to a number of different sensory stimuli that correlate with different features of the environment that are important to the organism’s self-maintenance and survival. For instance, if *Daphnia* swims too far away from the surface of the water to avoid predation or UV light, it risks freezing to death in the deeper, colder water, so the best place to be is as far down as it can go without risking cessation of metabolic activity. Neither the more general nor the more specific description requires appeal to representational states possessed by the organism that stimulate and guide its behavior toward its goal-state. Nor does either description rule out that *Daphnia* might rely on some kind of primitive representational states to determine swimming depth.

### **5.3. Utopic Behavior is an empirical testable account of Biologically Basic Agency**

Accounts of Biologically Basic Agency will identify a behavioral type or trait as (biologically basic) action(s), and subsequently the ability to perform such behavior as Biologically Basic Agency. These identified behavioral types or traits must be described in such a way that we can look at the empirical data and consensus regarding the behavior of organisms and reject the identified behavioral type if not supported by the data. This rejection will be either on the grounds that the behavioral type identified does not exist or that it does not identify the right kind of biological category of the sort needed in an account of Biologically Basic Agency—as identified in adequacy condition 5.<sup>98</sup> This can be illustrated by revisiting why Kim Sterelny’s (2003) proposal of the Detection System as Biologically Basic Agency is empirically inadequate as both a Strong Evolutionary construal of a biological type (or trait) and a Good Trick construal of a biological type (or trait).

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<sup>97</sup> As well as other directions.

<sup>98</sup> As we saw in Chapter 2 in developing this adequacy condition, Tyler Burge’s (2009) account of Primitive Agency can be modified almost endlessly to cohere with the empirical findings, no matter what they might be.



Kim Sterelny's identification of Detection Systems—those that produce feature-specialized behavioral responses that are triggered by a single environmental (sensory) signal—as a foundational kind of agency in the organic world makes clear empirical commitments regarding the fact that this behavior is exhibited by very simple organisms (like bacteria) and is widespread throughout the organic world. We should see such modular behavioral systems in many different organisms within many different lineages. However, before getting too far in this discussion, it must first be noted that Sterelny (2003) intends to offer a Strong Evolutionary account of the Common Trajectory variety—such an account identifies a simplest biological trait that has appeared in many different lineages but does not hold that all instances of this trait are inherited from the same common ancestor. Strong Evolutionary accounts of the Common Trajectory variety are, broadly speaking, not plausible. But putting this issue aside for a moment, in order to provide such an account, the behavioral type identified needs to be broadly distributed—“ubiquitous” in Sterelny's words—and typical or normal for the organisms in which it appears. However, as we saw in Chapter 3, organisms do not typically set up to produce a single adaptive behavior to a single feature of the environment, triggered by a single stimulus. Moreover, the theoretical framework and related empirical work in ethology that Sterelny relies upon for his empirical exemplars of Detection Systems has been summarily rejected. Indeed, the current consensus is that single signal, single response behavioral modules describe atypical or dysfunctional behavior in animals. Furthermore, the fact that such behavior is neither typical nor ubiquitous rules out the Detection System being used to provide a Good Trick style of biological classification as a proposed account of Biologically Basic Agency. Good Trick biological categories identify general functional types that are broadly distributed across many species and are typical of the organisms that possess them, and are, generally, adaptive—not atypical or the product of dysfunction.<sup>99</sup>

Finally, as we saw in Chapter 4, the Detection System—or feature-specific behavioral responses understood more generally—cannot provide a Strong Evolutionary construal of biological categories of the Common Ancestor variety. In a Common Ancestry grounded biological category, traits are grouped together because all organisms that

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<sup>99</sup> Furthermore, the Detection System is also unlikely to include human agency (as a Good Trick conception of Biologically Basic Agency would need to do) since Sterelny explicitly opposes Detection Systems and intentional agency—they are at different ends of the evolution of agency.

possess that trait have inherited it from a single common ancestor. So, we should see feature-specialized behavior in the appropriate sorts of organisms, like single-celled organisms or simple animals (the two likely points of origin for the agency found amongst human beings). However, it is highly unlikely that Detection Systems exist in single-celled organisms or very simple animals. In the first place, *prima facie* obvious examples of Detection Systems in model organisms such as the diel vertical migration of *Daphnia pulex* or the phototaxis of *Chlamydomonas reinhardtii* do not instantiate Detection Systems or feature-specialized behavior more generally. In the second place, feature-specialized behavior is not typical of life on Earth (a point carried over from Chapter 3). Even the “simplest” single-celled organisms or the “simplest” animals, like all organisms, are continuously producing a variety of behavioral responses that are mitigated or influenced by many different features and signals relating to those features in their environments. This is, more or less, just what it is to be a living organism.

Sterelny’s proposal as to what behavioral type—the Detection System—constitutes Biologically Basic Agency is empirically testable and refutable given what we should expect to see in both Strong Evolutionary and Good Trick construals of the kind of category agency should be. And it does appear to be refuted on these grounds. With this discussion in mind, I can now turn to showing that Utopic Behavior, as an account of Biologically Basic Agency, is testable in the same manner as Sterelny’s account, and also show that Utopic Behavior meets adequacy condition 5, as it offers a plausible Good Trick type of biological category.

#### **5.4. Utopic Behavior is not workable in a Strong Evolutionary story**

Utopic behavior could not credibly afford us a Common Ancestor version of a Strong Evolutionary Story and thereby link all agents together in the same category in virtue of possessing a shared trait inherited from a common ancestor. This is because the very general behavioral type it identifies cannot be coherently thought of as a *simplest* common ancestor for all more sophisticated agencies for many of the same reasons that

Sterelny's Detection System cannot play the role required by evolutionary accounts of Biologically Basic Agency.<sup>100</sup>

In the first place, the organisms in which I have identified Utopic Behavior—*Daphnia pulex* and *Chlamydomonas reinhardtii*—implement this behavioral type using vastly differing levels of physiological and anatomical complexity and organization that were derived at vastly different points in the evolutionary history of life on this planet. *Daphnia* uses a nervous system, distinct sensory organs, and large, complex antennae to propel itself through the environment. *Chlamydomonas* is single-celled, lacks distinct sensory organs, nervous systems, and complex appendages like those of arthropods. The Utopic Behavior that each of these organisms produces cannot be combined into a single common ancestral behavioral trait from which all more sophisticated agency will evolve. Moreover, given the vast differences in how Utopic Behavior is implemented by *Daphnia* and *Chlamydomonas*, it is highly unlikely that this behavioral trait is homologous—that they share a common ancestor with respect to their Utopic Behavior.

Indeed, the ability to move about one's environment under one's own power and the various mechanisms enabling such motility have evolved multiple times under similar and differing circumstances in various lineages. If we consider the flagella alone, which *Chlamydomonas* relies upon to propel its swimming, we see that similar structures have emerged at least three times from different mechanisms in different lineages—in Bacteria, Archaea, and Eukaryota. This has led to the desire on the part of some biologists to use the terms “flagella” and “flagellum” for the structures found in bacteria and refer to the analogous structures in eukaryotes (like *Chlamydomonas*) as “cilia,” and “archaellum” in Archaea. Various types of propulsive locomotion that do not rely on “flagellar” structures have also emerged at multiple points in various lineages—various types of crawling, twitching, “walking” (like in amoebae—called “amoeboid movement”), and swimming without flagella (by contractile motion of the body). Various eukaryotes have lost their ciliary heritage and must move around without them (Carvalho-Santos, Azimzadeh, Pereira-Leal, & Bettencourt-Dias, 2011). This is the only variety and discontinuity found among unicellular organisms. Once we move beyond unicellular to multicellular organisms (like *Daphnia*), we find that swimming, walking, etc. have all evolved multiple times in multiple lineages from many different mechanisms under

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<sup>100</sup> See Chapter 3 for the complement of problems facing the Detection System.

different selection pressures at different points in the history of life on this planet (Albers & Jarrell, 2015; Faguy & Jarrell, 1999; Jarrell & Albers, 2012; Jarrell & McBride, 2008). Utopic Behavior, therefore, almost certainly does not have a single evolutionary origin, and has likely emerged in many different lineages at many different points in the evolution of life on this planet. Thus, if Utopic Behavior is to constitute a biological category, it must be of the Good Trick variety.

## **5.5. Utopic Behavior will work on the Good Trick categorization scheme—like camouflage, heterotrophy, and autotrophy**

While it is unlikely Utopic Behavior can fit a Strong Evolutionary model of biological categorization, I believe Utopic Behavior does describe a biological category akin to that of concepts like heterotrophy, autotrophy, and camouflage. Utopic Behavior identifies a general strategy that can be implemented by many different organisms via a number of different, sometimes overlapping, sub-strategies, very much like what we see with camouflage, heterotrophy, and autotrophy. In what follows I will use camouflage and heterotrophy as the core illustrative cases for showing that Utopic Behavior can be readily construed as this kind of biological category.

Camouflage is typically identified as coloration, patterns, or other morphological features that an organism exhibits that enable an organism to avoid detection or identification by other organisms (Merilaita, Scott-Samuel, & Cuthill, 2017). Camouflage, then, is a broad strategy that is implemented by many different organisms in many different ways with diverse evolutionary histories. With respect to avoiding detection (also known as crypsis), there are strategies such as background matching, where the organism's coloration allows it to blend in with its background; disruptive camouflage, like spots or stripes on animals that make it difficult to visually determine the outlines of an animal and its movements, thereby making it difficult to detect; and countershading, where an organism has a gradated color scheme (typically light on the bottom, dark on top) that obscures the shadows one generates on one's own body in virtue of being an illuminated three dimensional object, making one look "flat." There are other cryptic camouflage strategies, but this suffices to make the point. Beyond cryptic camouflage, there is also "mimetic" camouflage that depends primarily on looking like some other element of one's environment so that other organisms searching for them will mis-

categorize or misidentify the individuals after they have been detected. Well known examples of this are known as “masquerade” and “Batesian mimicry.” In masquerade, organisms take on the appearance of inanimate and inedible objects in the environment. A number of insects have evolved to look like twigs, rocks, bird droppings etc. and by resembling such objects avoid predation. In cases of Batesian mimicry, one animal mimics the coloration of another similar animal that is poisonous or otherwise inedible. Such familiar cases are those where one edible animal (for a given set of predators) has evolved to have a similar coloration pattern to species that are not edible (for those predators).<sup>101</sup> Strategies like masquerade and background matching (and other cryptic strategies) can also overlap. Some caterpillars that exhibit masquerade also benefit from crypsis (Skelhorn & Ruxton, 2011). Furthermore, there is some research proposing that there are types of cryptic camouflage that are not visual, like mechanoreceptive camouflage, camouflage by sound, and chemical camouflage (Ruxton, 2009). Finally, the evolutionary stories and trajectories within and across the various kinds of camouflage are varied—Strong Evolutionary stories regarding how cryptic camouflage, masquerade, and Batesian mimicry evolve are unlikely to hold (Nelson, 2014).

Similarly, heterotrophy, as a biological type, includes a vast array of strategies of varying complexity for acquiring energy by ingesting various chemicals or organic material. Broadly speaking, one can engage in parasitism, be a predator of some kind, or be a grazer, an herbivore, a carnivore, an omnivore, etc. For example, fungi eat, to a large degree, by leaking digestive chemicals that break down the structure of the organisms on which they sit and grow and then absorb the digested nutrients from the resulting “soup.” Paramecia beat their cilia, generating currents over their single-celled body and thereby drive organic matter and a lot of water into their oral groove (Verni & Gualtieri, 1997). Various other organisms (cows, deer, horses, etc.) walk about and find patches of grass to bite, chew, and swallow for their stomachs to digest. Fruit flies deploy a proboscis (probably most familiar to us as the kind of apparatus mosquitoes use to suck our blood) in order to suck up putrefied fruit (Getting, 1971). With the variety of sub-strategies present within the more general strategy of eating, and a similar point clear in

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<sup>101</sup> For some time, the viceroy butterfly was thought to mimic the monarch butterfly in this way, but it has turned out that the viceroy is also toxic—so the monarch and viceroy are Müllerian mimics, see Ritland and Brower (1991). In Müllerian mimicry each unpalatable co-mimic benefits from the mimicry because predators require fewer attempts at eating either species before avoiding both of them while looking for food.

the case of camouflage, I can now turn to showing that Utopic Behavior describes the same kind of biological category.

### **5.5.1. How Utopic Behavior is like camouflage and heterotrophy**

Utopic Behavior describes a general strategy that is implemented by many different organisms in many different ways via diverse sub-strategies. Many behavioral orientations throughout the environment in a variety of organisms are effectively described as Utopic, i.e., aimed at finding a best overall position in the environment relative to a number of environmental features relative to the self-maintenance of the organism.

Utopic Behavior is also widely distributed among single-celled organisms, and is not limited to fairly “simple” multicellular organism like *Daphnia*. Fruit flies, for example,<sup>102</sup> orient around their environments utilizing a number of “external” sensory inputs—visual, chemical, and tactile inputs linked to a number of features of the environment. These features are relevant to many of the organism’s vital needs, some of which will provide “internal” signals (like indications of calorie needs), which also feature into the biasing of the organism’s behavior, given its most pressing needs at the time. In the case of finding food, for example, fruit flies depend upon olfaction to sense chemical plumes released by decaying fruit, which tend to increase in concentration (are less diffuse) the closer one gets to the source of the odor plume. This concentration information itself is ambiguous to a large degree when encountered without any wind direction information. This is because odor plumes are not typically consistent with respect to there being a clear gradient of chemical concentration from the odor source to the furthest point the plume has reached from the source. Plumes are irregularly diffuse, in part, because of air current interaction. So, wind direction, which provides disambiguating information with respect to the origin of the plume, is needed to use the plume’s gradient information effectively. This wind and chemical information is also integrated with visual information like that concerning optic flow, which gives the fly information about how fast it is moving and whether the wind in the environment is pushing it sideways, forward, or backward, etc., and allows the fly to approach the rotting fruit once it is in visual range (Becher,

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<sup>102</sup> And another instance of a model organism like *Daphnia pulex* and *Chlamydomonas reinhardtii*.

Bengtsson, Hansson, & Witzgall, 2010; Becher et al., 2010; Fuller, Straw, Peek, Murray, & Dickinson, 2014). Fruit flies, at low velocities, fly toward expanses (visual stimuli that expand in the visual field as one gets closer) and away from fast moving visual expanses. This enables flies to move toward objects like fruit and avoid objects like other flies, incoming hands, etc. (Reiser & Dickinson, 2013). Fruit flies also like vertical edges for landing (van Breugel & Dickinson, 2012)—this is why if they are in your kitchen, you will often find them resting on the corner of a cupboard. Once landed, fruit flies will walk much as they have flown, i.e., toward the strongest source of odorant using olfactory input along with air current input and various visual inputs concerning optic flow. Once the fly has walked to a liquefied part of the fruit's surface, neurons on its legs trigger the extension of the fly's proboscis into the liquid and the fly is then able to suck up its nutrition.

Ants<sup>103</sup> find food by very much the same method as flies, although primarily by walking rather than flying, through the use of chemical plumes along with wind reception and visual input concerning optic flow (Buehlmann, Graham, Hansson, & Knaden, 2014; T. S. Collett & Collett, 2000). The local humidity determines how many ants leave the nest in search of food and how quickly outgoing foragers return; the more quickly foragers return, the more foragers go out (Gordon, 2013). Ants manage returning to their nests once food has been acquired or an expedition has been unproductive by a process of “dead reckoning” whereby the ant's nervous system is able to calculate the trajectory back to the nest based upon information from its “sun compass” and the steps and turns it has made along the way (M. Collett, Collett, & Wehner, 1999; Knaden, 2006; Lehardt, Koch, & Ronacher, 2012; Lehardt et al., 2012). This dead reckoning, though, will not by itself lead the ant successfully back to its nest. The dead reckoning is buttressed by visual matching between a stored image of the landscape around the nest—the light-dark contrast between the sky and the horizon—to the horizon currently visible (T. S. Collett & Collett, 2002; Franz, Schölkopf, Mallot, & Bühlhoff, 1998; Lent, Graham, & Collett, 2010; Philippides, Baddeley, Cheng, & Graham, 2011). This horizon matching is also not sufficient for reaching the nest either—the final part of the nest relocation again relies upon olfactory sensation and wind information. Ant colonies have distinctive chemical markers (as do the members of each nest), so it is the concentration of this

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<sup>103</sup> Another popular model organism.

chemical in the air and the wind information that helps the ant find the source of the chemical plume and to finally reach an opening to the nest (Schultheiss & Cheng, 2011; Steck, Hansson, & Knaden, 2009; Sturgis, Greene, & Gordon, 2011).

In both the ant and fly cases, we see orientation relative to a number of survival or self-maintenance relevant features of the environment and their associated sensory inputs toward a best overall place to be (at a given time, relative to the immediate importance of certain biological needs such as how calorie depleted one is). Indeed, we could think of the ant's moving out to get food and its movement back to food as changes in the organism's environmental conditions—having food as opposed to not having food, it being too late to be out if one does not have food—or as shifting the location of the best place to be in the environment. Once the food is acquired (or once it is too late to be out still looking for food), conditions for the organism have changed, and thus the nest is now the “best place to be” (rather than where the food is or might be). The ant orients back to this location via the variety of sensory signals and internal states that enable it to reach this location in the environment. We can think of the complex homing and nest building as a “nexus” point of good places to be throughout a given day—where food is, where the colony is, where the rubbish heap is, and then back again, at one location in the nest, and then another. There is just a spot that is, on average, “optimal” compared to other spots. Animals like ants wind up with persistent, regular “good places”—like nests—which is where ants find protection from the elements, predators, etc. But of course, the good places are not eternally so. Ants must leave for food, to take out refuse, etc. So, like *Chlamydomonas* and *Daphnia* organisms, ants and flies also have to continuously adjust their location within their environments. There is no persistent “best” place.

The behavior of flies and ants, along with similar orientational behavior that is observed throughout the animal kingdom—lizards crawling into and out of sunlight, various herbivores finding shady spots for grazing, dogs and cats finding a solitary, cool or warm place to sleep—shows that orienting toward a good place is relative to a number of environmental factors and is a broadly distributed behavioral type that likely has multiple origin points over the course of the evolution of life on this planet. It should, by now, not be surprising that there are various organisms across various lineages that have evolved the ability to balance a number of their basic biological needs by altering their location in their environments. The ability to move toward resources and away from harmful



elements of the environment provides something of an advantage over one's conspecifics or other closely related competitors that cannot do the same. This is generally taken to be the selective advantage that the ability to move around one's environment provides as well as an explanation for why it has evolved in many lineages in many ways—independently so among eukaryotes, archaea, and bacteria (prokaryotes) (Carvalho-Santos et al., 2011; Khan & Scholey, 2018; McBride, 2001; Moran, McKean, & Ginger, 2014; Wadhams & Armitage, 2004). Selective advantage is particularly seen with respect to swimming over crawling, twitching, etc.; motility has been a driving force of the evolution of cilium (Beeby, 2018; Krell et al., 2011; Satir, Mitchell, & Jékely, 2008). Hence, Utopic Behavior is a Good Trick implemented by a number of organisms in a number of different environments and has evolved in various lineages at various points in the history of the planet.

Having established how Utopic Behavior constitutes a Good Trick kind of category by meeting various empirical expectations of such a categorization scheme, I can return to the earlier point regarding whether or not Utopic Behavior is an empirically refutable account of Biologically Basic Agency. If it were the case that Utopic Behavior was not found in diverse lineages, was atypical, or was only observed in dysfunctional organisms, this would give us reason to reject the view. Moreover, were it to turn out, despite present evidence, that, say, the most primitive single-celled organisms we can find (and so those probably most like the earliest to have evolved on Earth) exhibit feature-specialized behavior, we would have reason for rejecting or at least suspending judgment on Utopic Behavior as a plausible account of Biologically Basic Agency. On such findings, Utopic Behavior would fail to encompass the simplest kinds of agents and would possibly be “reducible” to feature-specialized behavioral modules that themselves interact or interfere with one another once an organism reaches a certain complexity. Fortunately, though, the empirical findings regarding organisms support Utopic Behavior as a Good Trick biological category. Feature-specialized behavior like that found in Detection Systems is an exception rather than the rule in the organic kingdom.

At this point, it would be helpful to summarize the results of this chapter so far. I have established that Utopic Behavior meets adequacy conditions 5 and 4—it describes an empirically testable biological category of the Good Trick variety (though it could not possibly work as a Strong Evolutionary category). Utopic Behavior also describes the behavior of organisms in representation-neutral terms, and so meets adequacy condition

1. With these conclusions in hand, it is now time to establish that Utopic Behavior describes a kind of goal-directed behavior (adequacy condition 2) that is distinct from behavior generally speaking (condition 3). Further, we can effectively situate human agency within the broad framework identified by Utopic Behavior.

## **5.6. Utopic Behavior is a kind of goal-directed movement**

We are fairly certain that human beings perform actions and thereby exhibit agency. Moreover, a central motivation for developing accounts of Biologically Basic Agency is the desire to explain and situate human agency relative to a broader biological context, particularly relative to the behavioral capacities of “simpler” organisms. In light of these motives, I believe that points of broad agreement in human-centric Modern Action Theory offer a promising start for determining the features that a conception of Biologically Basic Agency must have in order to effectively distinguish action from the broader class of behavior.

It would be difficult to dispute that one of the points of broadest consensus found in Modern Action Theory is that actions are paradigmatically goal-directed motor behavior.<sup>104</sup> <sup>105</sup> So, if 1) Modern Action Theory is right in accepting that goal-directed motor behavior provides the paradigmatic cases of action, and 2) it were to turn out that the “goal directedness” of a motor behavior renders a behavior an action (as distinct from the general category of behavior) in human beings, then it would be nice, theoretically speaking, if “goal directedness” could be similarly used to distinguish between action and the broader class of behavior in an account of Biologically Basic Agency.

However, before much work can be done using this Modern Action Theoretic consensus to shape and evaluate accounts of Biologically Basic Agency, two potentially conflicting facts need to be addressed. The first is that Modern Action Theory is primarily concerned with the agency of adult human beings along with our full complement of

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<sup>104</sup> I exclude broad agreements like the following—that actions and agents exist, humans perform actions—because I think anyone offering an account of agency accepts, at least tentatively, these claims.

<sup>105</sup> For some dispute as to whether this consensus is the right one see Baier (1981) and Thompson (2010).

representational, neurological, and cognitive capacities. The second is that it is not yet clear exactly “how far down” an account of Biologically Basic Agency should go or how broadly agency may be distributed in the organic kingdom. Plausible and promising accounts of Biologically Basic Agency might well extend to cover behavior found in single-celled organisms. So, the ideas drawn from human-centric action theory will need to be modified and adapted when applied to accounts of Biologically Basic Agency. Fairly straightforwardly, we will be looking for a non-representational interpretation of the “goal directedness” of behavior that can be applied to very simple organisms—possibly single-celled organisms—that are unlikely to possess any goal representing mental states like intentions, desires, etc. that are (typically) employed in Modern Action Theory.<sup>106</sup> Further, “motor behavior” usually refers to neural control of behavior (often in human beings).<sup>107</sup> Again, given that agency may extend to very simple organisms that lack nervous systems, it would be useful to expand the notion of “goal-directed motor behavior”<sup>108</sup> to “goal-directed movement,” which will have broader biological application.<sup>109</sup>

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<sup>106</sup> Though, someone like Ruth Millikan (1989a) might think such creatures do possess rudimentary representational capacities.

<sup>107</sup> See Adolph and Franchak (2017); d’Avella, Saltiel, and Bizzi (2003); Kandel (2013).

<sup>108</sup> Other modifications may be necessary as well, but these will certainly be required.

<sup>109</sup> The strategy I am employing here is effectively that of seeking a “Reflective Equilibrium” (Rawls, 1971). We start with a plausible or common conception of agency (broad agreement in human-centric Modern Action Theory), along with a set of constraints for how a theory of Biologically Basic Agency should go (like representation-neutrality, etc.), and see how the starting conception needs to be adjusted and interpreted in light of the empirical findings regarding the behavior of organisms. However, it is not only the starting conception that can be modified in light of the other two points in the nexus. As we progress in developing our accounts of (in this case) Biologically Basic Agency, any point in the nexus may require adjustment in the other. For example, the constraints on what we think a conception of biologically basic should look like may need to be altered because they are not consistent with the empirical findings or they do not cohere elements of the starting conception of agency that are well justified. Further, which empirical facts are relevant to developing an account of Biologically Basic Agency might be changed in response to well justified constraints on any theory of Biologically Basic Agency, or well justified elements of the action theoretic consensus. The hope is that by working in this way, we will end up with a reasonable and coherent conception of Biologically Basic Agency that is derived from both the empirical findings regarding the behavior of organisms and our commitment to the existence of human agency (which should be an instance of Biologically Basic Agency, but not the only one).

### 5.6.1. Utopic Behavior is goal-directed movement, but virtually all behavior can be described as goal-directed—motor or otherwise

If we think that an account of Biologically Basic Agency should offer a broad conception of non-representation dependent “goal-directed movement,” then Utopic Behavior appears to fit the bill. Consider again the case of the phototactic alga *Chlamydomonas reinhardtii* (discussed in Chapter 4). The movement of phototactic algae toward and away from light of a certain variable intensity range can readily provide a familiar type of “just-so story” granting it a clear biological function. Such behavior could plausibly provide a reproductive advantage over organisms that lacked this ability in the evolutionary past. Being able to move toward and away from light of varying intensities would enable phototactic algae to find (or at least get close to) the “sweet spot” for photosynthesis—one that enables a large amount of energy absorption but not so much that the cell is likely to be damaged. Algae that kept swimming into light of ever-increasing intensity without ever turning around would have died or been seriously damaged, and so would very likely have reproduced less effectively than cells that turned away from light that is too intense for safety. Similarly, cells that only turned away from light would likely not have photosynthesized well and so would not have lived long (or would not have been very healthy) and would likely not have reproduced as successfully as the cells that moved toward the light but away from light that is too intense.<sup>110</sup> If one allows for this (or a similar) attribution of biological function to phototactic orientation, then this kind of movement in *Chlamydomonas reinhardtii* has the purpose or goal<sup>111</sup> of reaching an ideal (or at least good) location for photosynthesis.<sup>112</sup> (A similar story would follow for *Daphnia pulex*.) Unfortunately, we cannot stop here. By conceiving of goal directedness in non-representational terms, the

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<sup>110</sup> This just-so story is for illustration purposes only. I do not mean that these are the varieties of behavior that selection actually chose amongst in the actual history of phototactic algae.

<sup>111</sup> We could also appeal to our intuitive judgments—the behavior *looks* goal-directed, whether we appeal to a bio-functional analysis or not. One could reasonably hold, it seems to me, that this is the notion of goal directedness at play in our everyday attributions of action. Regardless, whatever the basis for the attribution of goal directedness, there is a fairly straightforward sense in which the behavior of *Chlamydomonas* would be described as goal directed.

<sup>112</sup> We could also likely say that utopic systems generally have the function, purpose, goal of moving toward the best overall place to be in the environment.

account preserves the first adequacy condition; however, it is now in danger of violating the third, for it appears that all behavior could count as “goal-directed” movement.

Every behavior exhibited by an organism will involve movement on some part of the organism,<sup>113</sup> and nearly every trait of an organism—behavioral or otherwise—can be described as “goal-directed” in terms of “what it is for:” why, historically, a particular trait led to greater reproductive success than its rivals and so was preserved in current populations because of this greater reproductive success (or presently, why a trait leads to greater reproductive success).<sup>114</sup> So, in terms of “goal directedness” or “goal-directed movement,” there is nothing to distinguish Utopic Behavior from the behavior of organisms generally. Consequently, some reasonable narrowing of the class of “goal-directed movement” other than “goal-directed motility” is still needed to ground a distinction between action and behavior for general accounts of Biologically Basic Agency.

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<sup>113</sup> As noted in Chapter 2 in Section 2.5, there are some processes within cells and organisms that probably do not count as behavior—various forms of passive transport like osmosis do not require any energy expenditure on the part of the cell and do not depend upon any part of the cell to move in order for ions to pass through a cell’s membrane and establish equivalent levels of concentration inside and outside the cell.

<sup>114</sup> There is some debate regarding which facts determine the “function” of a biological trait—whether it should be dependent on the trait’s having been preserved because it enabled greater reproductive success relative to its variations and rivals in evolutionary history (an “etiological” account), or whether it should be understood in terms of its current “fitness” effects—reproductive success in a currently living population (a “propensity” account) (Bigelow & Pargetter, 1987; Millikan, 1984, 1989b; Neander, 1991; Sterelny & Griffiths, 1999)—or some combination thereof (Godfrey-Smith, 1994). Beyond these conceptions of biological function is the physiologically motivated notion of function whereby a trait or organ has a function in virtue of what it does within the whole system of the organism—for example, the heart has the function of pumping blood because that is what it does in the organisms that have hearts (Roux, 2014). Such an analysis of function is not far removed from that offered by Robert Cummins (1975), which indexes the function of any component of a system to the explanatory aims of those investigating the system. I am focusing on behavioral traits of organisms, and I only need the reader to get a sense that it is relatively straightforward to establish a biological function for a behavioral trait (whatever the ultimate correct analysis of biological function turns out to be). The key point is that there are many readily available means of assigning functions, and thereby goals, to the behaviors of organisms.

## 5.7. Distinguishing Utopic Behavior from behavior generally

The feature of Utopic Behavior that I believe will allow us to distinguish it from the class of behavior generally is that Utopic Behavior centrally involves moving around the environment, rather than simply moving one's internal parts or moving one's external parts within an environment. I recognize, though, that this may strike some as initially implausible. After all, virtually every organism exhibits quite complex and sophisticated responses to environmental stimuli—even plants bend toward light and turn their leaves toward sunlight. However, I think that the ability to move around the environment to meet one's biological needs provides organisms with a distinctive solution set to the problems that all organisms face, but it's a solution set that not all organisms have access to or that all adaptive behaviors can offer.

It is difficult to say exactly what the difference is other than to point out the difference in behavioral options being able to move about the environment provides. But let us try this: if the nutrition sources of one's local environs are drying up, one can move toward a new location where they might be. If one's environment becomes toxic, one can leave. If there is another organism that is out there to eat you, you might be able to move out of its habitat range or at least its effective hunting range.

This is not a kind of flexibility or adaptability available to organisms that cannot propel themselves about the environment, no matter how far they can grow or how much they can twist or bend (tropisms) from their fixed base. If a tree's local environs become nutrient depleted or the soil becomes too acidic, for example, the tree must shed its leaves and wait for conditions to improve or put resources into internally mitigating the effects of environmental acidity. If it is too cold, the cold must simply be endured, usually by slowing or halting metabolic processes until conditions are more favorable. Single-celled organisms that lack the ability to propel themselves about must depend upon water (or other fluid) currents to move them and indeed, many of these organisms tend to attach to surfaces, clumping together, and do not leave this anchored position even if the environment becomes inhospitable (Lurling & Beekman, 2006). The point bears repeating: it is simply not surprising that various organisms across various lineages have evolved the ability to balance a number of these basic needs by altering their location in their environments. The ability to move toward resources and away from harmful

elements of the environment provides something of an advantage. As noted in Section 5.5.1 above, this is generally taken to be the selective advantage that the ability to move around one's environment provides and why it has evolved in many lineages in many ways, and independently among eukaryotes, archaea, and bacteria (prokaryotes). (See again, McBride 2001, Wadhams and Armitage 2004, Carvilho-Santos et al. 2011, Moran et al. 2014, Satir et al. 2008, Krell et al. 2011, Beeby 2018). Consequently, the ability to behave in a Utopic way affords behavioral options—particularly the ability to relocate in light of one's global environmental conditions—not provided by other behavioral strategies, even those that involve movement of one's parts within an environment from a fixed base (or as one is pushed around one's environment by fluid currents). Thus, Utopic Behavior has features that are not common to all behavior and so constitutes a distinctive behavioral subtype.

## **5.8. Establishing the continuity of human agency with that of other organisms, or why Utopic Behavior is not an ad hoc account of Biologically Basic Agency**

I have established that Utopic Behavior is a distinct subset of organic behavior and have shown that Utopic Behavior meets the adequacy conditions for an account of Biologically Basic Agency developed over the course of the first four chapters (see Section 5.1). Consequently, we have good reason for thinking Utopic Behavior is an account of Biologically Basic Agency with a baseline plausibility. After all, these adequacy conditions are not easily met, even for other proposals that have a good deal of intuitive appeal. The accounts of Biologically Basic Agency offered by Tyler Burge (2010) and Kim Sterelny (2003) (discussed in Chapters 2 to 4) both fail to meet all conditions. So, at the very least, I have established that the Utopic Behavior account of Biologically Basic Agency is superior to those offered by Burge and Sterelny. However, despite these results, I think one could wonder why *this* behavioral type—Utopic Behavior—should be thought to pick out a meaningful account of *agency*. One could reasonably ask: why is the identification of Utopic Behavior as Biologically Basic Agency not *ad hoc*, merely chosen for the purpose of finding *some* behavioral type that meets the adequacy conditions I have identified? After all, Utopic Behavior was more or less “discovered” in Chapter 4 during discussion of problems facing Kim Sterelny's (2003) view of agency.

Perhaps any number of behavioral types we might discover could meet these basic conditions of adequacy for accounts of Biologically Basic Agency.

As indicated in the introduction to this chapter (Section 5.1) and in Chapter 1, I do not think that merely meeting these adequacy conditions is enough to demonstrate that a proposed account of Biologically Basic Agency is promising or plausible. Moreover, the “ultimate” test of any account of Biologically Basic Agency—once one has met the adequacy conditions I have identified—is how well the account can demonstrate a continuity between human action and the other, often simpler, agencies found amongst other organisms (as identified by the theory). After all, the primary aim of and motivation for developing an account of Biologically Basic Agency is to situate human agency—particular human motor action—within a broader biological context. To so situate human agency, a Good Trick account of Biologically Basic Agency like that provided by Utopic Behavior will need to show that human agency exhibits the same properties exhibited by other agencies on the phylogenetic tree as identified by the theory. Therefore, if much (or most or all) of the goal-directed motor behavior taken to be the prototypical cases of action theorized in Modern Action Theory can be shown to fall within the identified category (in the present case, Utopic Behavior), we have non-arbitrary grounds for thinking that we have identified a promising account of Biologically Basic Agency and not merely an account that happens to meet the basic adequacy conditions I have identified.

I do not think it will require much space to make a convincing case that a substantive portion of human action with which we are familiar fits readily into the class of Utopic Behavior. Much of what we do is focused upon moving ourselves to a current “best overall place to be” relative to a number of biological needs and related sensory inputs. We find cool places to be on hot days, warm places to be on cold days; we shift position on the couch when we get too warm, too cold, or the sun is in our eyes; we head to the library, get under blankets, go to the grocery store, make our way to the dinner table, to the fridge, or to the cupboard; go where the potential mates are, and so on. In the case of heading to the dinner table, for example, we very likely have our hunger—our biological need for nutrients—which mediates how strongly sensory inputs such as the smell of food will affect our response to its presence. Other indicators such as visual contact with the food will also enable us to head toward the potential meal, the strength of our visually mediated response influenced by the degree of our hunger. Further, if it is a very hot day and the food is very hot, despite how hungry we are, the food may not be as



motivationally powerful even though visual, olfactory, and possibly aural signals indicate its presence. Similar features will hold for hot drinks on hot days for many of us.

Straightforwardly, I think, we would normally describe our own behavior in terms of beliefs, desires, and intentions, but it is good to note again that an account of Biologically Basic Agency is to be representation-neutral. In the above cases, much of our typical behavior can be described accurately in representation-neutral terms, like getting up and moving from the couch to head to the dinner table, seating ourselves in order to be in position to eat food. However, while it might be that we can describe our movement about our environment in (representation-neutral) utopic terms, there is much more to our movement and to our motor behavior than simply moving toward or away from where it would be best to be at a given point in time with respect to our various biological needs. We also manipulate objects, pick them up, and move them around the environment. I believe that this feature of our behavior can be seen, in our case and that of other organisms, as instances of Utopic Behavior.

### **5.8.1. Manipulative Utopic Behavior**

Beyond the ability to move one's self around one's environment (toward a best overall place to be), I think manipulative behavior can be seen to fit readily within the Utopic framework. Take a simple example to start, like the mating behavior of *Daphnia pulex*. When conditions are favorable—daphnids are at a sufficiently high concentration, the temperature is tolerable, and food has not been too scarce—a male daphnid that bumps into another daphnid will give chase to the daphnid it has bumped into it. It does so by following the fleeing daphnid's wake of water displacement. It must follow closely; if it falls more than a few body lengths behind it will lose the trail. Having caught up to the daphnid, the pursuer will attempt to grasp on to the other daphnid and position itself over the other daphnid's abdomen. If the other daphnid is female, then the male will have a reasonably high likelihood of success in grasping—female daphnids are larger than males, and their carapace has convenient “handholds” for the primary antennae of daphnids (which they use to grasp one another). Once the male daphnid has hold of the female daphnid, it navigates over the body of the female toward the abdomen and then uses its claws to penetrate the female's abdomen (close to where its egg sack is located), thereby inseminating the female. Throughout this procedure, the male daphnid is primarily engaged in orientational behavior, first toward, and then over the surface of

the female it has caught. Here, being in the appropriate position for mating constitutes the best overall place to be at the present moment. When one male has chased down another male daphnid, however, the pursuing male attempts to grasp the other male but cannot. Male daphnids are much smaller than the females, and males lack the “handholds” present on the female carapace. This mating behavior (which has been described as “fighting”) suggests that the characterization of “the best overall place to be” should be expanded beyond “a good place for preserving homeostasis or one’s life processes” to something akin to “meeting basic biological imperatives or needs.” Mating is sometimes inconsistent with staying alive—most of us are likely familiar with the fate of the male praying mantis (males are consumed by the females for nourishment after mating). Expanding the characterization to focus on basic biological imperatives is, to my mind, a natural move, primarily because the function of any biological trait is derived from the role that trait plays in an organism’s reproductive success. We might then think of reproduction as the “master” goal of every organism (whether it can successfully be achieved or not) and think of every other goal of an organism’s behavior that can be assessed a biological function as derivative from this “master” goal.<sup>115</sup>

This basic insight regarding movement and manipulation by organisms can be taken further. A similar case can be made for the ways in which ants manipulate and move objects around in their environments. Ants grasp objects with their mandibles and then walk about while holding on to prey, dead conspecifics, building material, etc. The ability to move around one’s environment, to grasp objects and move them around in the environment—back to where it is safer to eat, etc.—often fosters construction of a best place to be such as one’s nest, one’s hive, etc. Indeed, this change of circumstances is an environmental feature determining the best overall place to be for meeting various biological needs; an ant’s returning to the nest makes the nest the best place to be for the ant. Crawling over another organism to a particular spot correct for sexual engagement or picking up an object and moving it around is a kind of orientation around the object. Reorientation of the object is accomplished by reorienting one’s body or by

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<sup>115</sup> Here one might wish to note that when we act, we act to satisfy our particular desires, which may not be in service of our reproductive success at a given moment. However, at this level, the grain of analysis is coarser—we are looking at behavioral types, and every behavioral type, like eating or working as a cashier, can be seen as fulfilling a biological function appropriately related to one’s reproductive success. However, this does not entail that our behavior is never maladaptive—we sometimes overeat or eat food that is “bad” for us, but eating behavior has the function of keeping us alive by acquiring nutrients.

the parts of body involved in moving one around.<sup>116</sup> So, in Utopic Behavior (as with camouflage and heterotrophy), there are a number of sub-strategies that exhibit the generally characterized functional attributes of a broad strategy employed by many organisms across many different lineages and biological complexity. Such subclasses of biologically basic action would be things like mating, navigating, foraging, hunting, nest building, and others. All of these subclasses, at a broad level of functional description, are instances of organisms moving toward a best overall place to be relative to a number of germane features of the world pertinent to meeting the organism's shifting biological needs (which would be co-determined by the "internal" states of the organism).<sup>117</sup>

We can see, then, that familiar cases of our goal-directed motor behavior—actions—like sitting here typing at my computer requires the use of postural muscles that ensure that I am in a comfortable position relative to the placement of my hands, that I have set myself in front of the computer, and so on. The manipulation—pressing—of the keys on the keyboard, like most of our motor agency, depends upon using our limbs and postural muscles to move ourselves around objects in the environment and thereby move them around—as is the case when setting myself in position and pressing down on the keys of my computer. Moreover, the grasping of other objects, while not involved in an activity like typing, seems to be key in much of our manipulation of objects, just as it is in certain behaviors exhibited by *Daphnia* and ants. In order to grasp an object, we have to move our body parts into the appropriate position around the object and then move our hands or other body parts to exert pressure on the object so that it does not fall as we move it about. And in order to alter the object's location, we must use limbs and postural muscles to alter or maintain our position within the environment so that we can get our hands, say, to the right position relative to the object in order to get hold of it. This is so

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<sup>116</sup> Indeed, one might point out that movement of objects around the environment toward a best overall location makes that "best place to be" even better. So, carrying food back to a secluded feeding spot—like a leopard taking one's prey up a tree— not only provides a possibly shady location that might be more comfortable than wherever one found one's meal, but such locations also reduce the risk of food theft or of having to defend the procured meal from other organisms that might try to steal it. See also the discussion on ants and the idea of "nexus" in Section 5.5.1.

<sup>117</sup> At this point, we can say that a number of Burge's (2010) (see Chapter 2) intuitions regarding which behaviors are actions would be vindicated by this model, but we would have a more concrete, empirically checkable proposal that points us in much the same direction. Eating though, is not always going to count as an action—some eating just requires absorbing nutrients one has made available by digesting the organism (living or dead) to which one is attached, such as in the way Fungi secrete digestive chemicals and then absorb the externally digested matter into their cells.

whether we are engaged in a subtler manipulation and “positioning” process while we are sitting—like picking up one’s cup and taking a drink—or whether we are moving our bodies around more obviously, as in the case of picking up a coffee cup and taking it with you into another room. On this basis, I think it is fair to say that most, if not all, of our goal-directed motor behavior—the prototypical action targeted for explanation in Modern Action Theory—are instances of Utopic Behavior—moving about the environment relative to a number of information streams regarding a number of features that are relevant to meeting our basic biological needs, i.e., sustaining homeostasis and reproducing. Consequently, human agency is, to a large degree, of the same behavioral type as that identified in *Chlamydomonas* and *Daphnia*.

## 5.9. Conclusions

In this chapter, I have shown that Utopic Behavior identifies a behavioral type that inherently involves goal-directed movement, which admits of a Good Trick biological category, and establishes a continuity in action and agency deeply and broadly within the phylogenetic tree. Prototypical actions—goal-directed motor behavior—performed by human beings belong to the same behavioral type as those seen in motile single-celled organisms and quite simple animals. This allows us to see that Utopic Behavior, carved out as a distinct subclass of behavior on the basis of its inherently involving the capacity to relocate one’s self in the environment, is not *ad hoc*. These features of the account of Utopic Behavior as Biologically Basic Agency, along with its meeting the other conditions of adequacy set out in Chapter 1—that it offers a representation-neutral description of agency and is empirically testable—entail that Utopic Behavior is a plausible and promising account of Biologically Basic Agency that is, at a minimum, superior to the other accounts of Biologically Basic Agency discussed in Chapters 2 through 4—those offered by Kim Sterelny (2003) and Tyler Burge (2009).

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