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The Power and Promise of Developmental Systems Theory

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Aller au sommaire du numéro

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Résumé de l'article

Si les féministes n'ont pas eu tort d'être profondément sceptiques face aux nombreuses revendications de la biologie, leur attitude face à cette science doit être remise en question car la biologie s'est transformée au courant des dernières décennies. La « théorie des systèmes de développement » (*developmental systems theory*-TDS) est une théorie qui s'est considérablement développée et qui a pris beaucoup d'ampleur. Cette théorie n'accepte pas le concept d'essence biologique ce qui pose un défi important à la distinction nature/culture. Une des conséquences de cet apport théorique est que le scepticisme des féministes face à la biologie de l'évolution n'est plus justifié car la biologie ne comporte plus les contraintes essentialistes qui s'avéraient contentieuses. En effet, certaines féministes ont déjà trouvé des applications utiles pour la TDS et nous avançons que les féministes doivent maintenant élargir l'utilisation de la TDS car la portée de celleci pourrait être significative dans d'autres domaines tel celui de la théorie politique.

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88

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[1]THE POWER AND PROMISE OF DEVELOPMENTAL SYSTEMS THEORY[2]

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RÉSUMÉ

Si les féministes n'ont pas eu tort d'être profondément sceptiques face aux nombreuses revendications de la biologie, leur attitude face à cette science doit être remise en question car la biologie s'est transformée au courant des dernières décennies. La «théorie des systèmes de développement» (*developmental systems theory*-TDS) est une théorie qui s'est considérablement développée et qui a pris beaucoup d'ampleur. Cette théorie n'accepte pas le concept d'essence biologique ce qui pose un défi important à la distinction nature/culture. Une des conséquences de cet apport théorique est que le scepticisme des féministes face à la biologie de l'évolution n'est plus justifié car la biologie ne comporte plus les contraintes essentialistes qui s'avéraient contentieuses. En effet, certaines féministes ont déjà trouvé des applications utiles pour la TDS et nous avançons que les féministes doivent maintenant élargir l'utilisation de la TDS car la portée de celle-ci pourrait être significative dans d'autres domaines tel celui de la théorie politique.

ABSTRACT

I argue that it is time for many feminists to rethink their attitudes towards evolutionary biology, not because feminists have been wrong to be deeply sceptical about many of its claims, both explicit and implicit, but because biology itself has changed. A new appreciation for the importance of development in biology has become mainstream and a new ontology, associated with developmental systems theory (DST), has been introduced over the last two decades. This turn challenges some of the features of evolutionary biology that have most troubled feminists. DST undermines the idea of biological essences and challenges both nature/nurture and nature/culture distinctions. Freed from these conceptual constraints, evolutionary biology no longer poses the problems that have justified feminist scepticism. Indeed, feminists have already found useful applications for DST and I argue that they should expand their use of DST to support more radical and wide-ranging political theories.

INTRODUCTION

Evolutionary biology has been used at various times to explain and, at least implicitly, to excuse various forms and features of oppression. Whether through platitudes—boys will be boys—or careful experimentation and reconstruction of natural histories, biology, in both folk and academic varieties, has been used to paint politically suspect pictures of men, women and the relations between them. Typically, these imply the existence of essential traits that inevitably produce social roles in their bearers with predictable consequences concerning power relations, privilege and the division of labour. At least when it comes to sex difference, folk biology and scientific biology appear to be mutually reinforcing; and any scientific study that supports the prejudices of our folk biology tends to find eager repetition in the popular media.[3] The assumption seems to be that biological traits are essential, etched on our genes, and because they fundamentally constitute the individual it is foolish, if not immoral, to try to change them. Such reasoning has been used to excuse various oppressive relations, particularly those between men and women.[4] The implication is clear: patriarchy exists just as surely as any other natural feature of the world. It is unfortunate that natural selection produced it, but there is nothing to be done about it. Although social order and individual moral fortitude can mitigate its excesses, human nature, or more precisely masculine nature and feminine nature, will prevail. Little wonder that many feminists have viewed evolutionary biology, especially sociobiology, with a sceptical eye, focusing instead on the social construction of gender, oppression and liberation.[5]

In what follows I suggest that it is time for many feminists to rethink their attitudes towards evolutionary biology, not because feminists have been wrong to be deeply sceptical about many of its claims, both explicit and implicit, but because biology itself has changed. A new appreciation for the importance of development in biology has become mainstream and a new ontology, associated with developmental systems theory (hereafter DST), has been introduced over the last two decades.[6] This turn challenges some of the features of evolutionary biology that have most troubled feminists. DST undermines the idea of biological essences and challenges both nature/nurture and nature/culture distinctions. Freed from these conceptual constraints, evolutionary biology no longer poses the problems that have justified feminist scepticism. Furthermore, I will show that feminists have already found useful applications for DST and argue that they should expand their use of DST to support more radical and wide-ranging political theories.

My first task, then, is to clarify some reasons for the feminist turn away from biology and the cost of having done so. Crucial for understanding feminist fears of the implications of biology is the tendency towards essentialism implicit in much evolutionary biology.[7] After that I review key aspects of 20th century biology, explaining the role of genetics in grounding essentialism. The main feminist historian of this subject, Evelyn Fox Keller, is also one of its most important critics, so I depend heavily on both her account and her critique. Russell Gray's version of the central tenets of DST reveals how it provides an alternative approach to biology that no longer supports biological essentialism, or nature/nurture and nature/culture dichotomies.

In the final section I will explore the power of DST. It fits, I will argue, Helen Longino's pluralist model of a more democratic and objective scientific epistemology (1993) and thus has the promise to be a kind of successor biology. Furthermore, DST can be seen to offer a theoretical basis for feminist remarks on the interplay between cultural and political constraints and the physiology and anatomy of bodies. Indeed, I hope to show that DST furthers the aims of feminism in offering a picture of human life that suggests the real possibility of social change while still leaving the possibility of meaningful talk of human flourishing and harms. Through the lens of DST we see that human facts and human values cannot be simply separated, but are mutually informing. If we *do* change the facts of human biology through cultural and political structures based on our values then we can choose to change biology in accordance with at least some of the values that we hold most dear. Indeed, the same set of values, differently ordered, will give rise to different cultural/political structures with different models of human flourishing and different types of people and exemplary citizens. As such DST promises a biological basis for the possibility of radical political pluralism.

WHO'S AFRAID OF EVOLUTIONARY BIOLOGY?

The story of the feminist flight from biology given in the introduction might fairly be accused of over-simplification. There is, in fact, no one simple account of the relation of feminist theory to biol-

ogy. Nonetheless, the tendency to focus on the social at the expense of the biological might have a source in feminist attempts to engage the philosophical tradition. A central feminist project has been to include women in moral and epistemological discourse in meaningful ways. Thus the historical reduction of the female to the natural, and implicitly to biological necessity, has been a primary target of feminist theorizing. For example, Virginia Held's "Feminist Transformations of Moral Theory" attacks traditional ethics for excluding women from moral discourse altogether, by characterizing their function as natural and therefore beyond normativity. Building on Genevieve Lloyd's *Man of Reason*, Held tells a story of how theories of knowledge and morality disappeared women and their traditional work by relegating them to the domestic sphere of reproductive function, divorced from the public sphere of ethics, politics and science.[8]

Much of feminist ethics[9] and feminist epistemology (particularly, standpoint epistemology)[10] has worked to place women and their traditional labour at the centre of philosophical discourse, by showing that, as the slogan goes, "the personal is political." Making women's labour, lives and decisions exemplars of epistemic and ethical deliberation, despite their placement in the domestic sphere, suggests that the domestic sphere is social and political rather than natural. To be equal to men, women had to be seen as moral and epistemic agents, engaged political actors, rather than passive biological objects, governed by instinct (maternal and otherwise). Thus we can see that demanding a place within traditional philosophical discourse effectively meant minimizing the biological in favour of the social.

Feminists have not only worked to expand accounts of moral and epistemic agency within a traditional philosophical framework, but have also challenged that framework. One of the most important ways in which feminists have done this is through taking the body and experiences of embodiment seriously. Against the dualism associated with Descartes, feminists have defied prioritizing the life of the mind over the life of the body and have shown that dualism is descriptively false,[11] and that it normatively grounds an account of self that has effectively been used to hide the real effects of oppression and distort theories of autonomy and equality.[12]

It is prima facie strange that this feminist interest in the physical situation of people and their embodiment has shown so little connection with empirical biology. This can in part be explained by the fact that feminist philosophers who have incorporated embodiment into their theorizing have typically not been so much interested in the body *per se,* but in the *experience* of embodiment and the ways that embodiment affects ethical and epistemic judgement. Arguably, however, the turn away from biology means that the empirical base of this theorizing has been impoverished. After all, basic questions about bodily functions, requirements and development and the real limitations imposed on people by way of these facts about embodiment are empirical issues and biology is the science that investigates them. Moreover, as feminist biologists have suggested, if we are to fight oppression effectively, we need to understand the biological mechanisms that may support it.[13] Without some engagement with empirical biology, scepticism towards the scholarship that results from the current turn toward embodiment in feminist philosophy is warranted.

But scepticism of the biological sciences is also warranted. Biology is a favoured science of feminist epistemologists in part because it offers some of the clearest cases of the distorting effects of androcentric and sexist bias in science.[14] It is precisely this bias that makes it reasonable for feminists to avoid taking the results of biology too seriously. The history of biology and, in particular, some sociobiological accounts, justifies feminist caution. Londa Schiebinger's crucial text, *The Mind Has No Sex*, clearly demonstrates a history of biology focused on showing the essential differences between males and females. Moreover, she connects the history of naturalizing inequality to the political projects of the Enlightenment. If sexual inequality was simply part of *nature* then people fighting for women's liberation could make no appeal to *natural* rights, thus this science implicitly justified the social differences between men's and women's lives by appealing to biology.[15] Lloyd's recent analysis of the androcentrism of accounts of female orgasm[16] suggests that, though feminism may have had some positive influence on biology, much of biology still remains politically and scientifically suspect. Feminist theorists have reasonably been reluctant to add legitimacy to a discipline populated with accounts that, in Sarah Blaffer Hrdy's words, "have frequently been used to justify submissive and inferior female roles and a double standard in sexual morality."[17] The reasons that feminist research on embodiment has drawn so little from biology thus arguably rest with the discipline of biology itself.

Furthermore, when such biological claims are allowed into normative discourse, their status as science seems to have the troubling

effect of placing the claims beyond normative criticism. Thus we find that the force of biological accounts rests on the fact/value distinction, translated into the assumption that if a claim is scientific then it cannot be sexist. So, if scientific claims reify female inferiority, then a normative feminist theory that implicitly denies them is wrong by default. We see a paradigmatic example of such reasoning in Michael Ruse's essay, "Is Science Sexist?" Here Ruse defends sociobiology in general and Symon's view in particular from feminist attacks:

> It seems…that the only real line of defense against the charge of sexism is to show that the sociobiology of sex has some fair claim to being plausible. If women really do have an anxiety about having no penis and if this is a significant factor in their psychosocial makeup and behaviour, then one can hardly accuse Freud of being a sexist in drawing attention to the point: at least not in the context of an overall analysis of human sexuality. Analogously, if men and women really do respond to pornography in different ways because of their genes, then one can hardly accuse Symons of being a sexist in drawing attention to this point: at least, not in the context of an overall analysis of human sexuality.[18]

Of course, mere plausibility is a low standard; indeed, it suggests that only the ridiculous can be appropriately criticized as sexist. If biological accounts that justify sexual double standards or women's oppression are immune from feminist criticism unless they are impossible to believe on other non-feminist grounds, this seems to rule out effective feminist criticism before it has a chance to begin.

Clearly, behind Ruse's comment is a commitment to some version of the fact/value distinction. Science describes the facts; politics prescribes forms of social organization based on normative accounts of the just and the good. According to those holding such a view, and it is by no means unique to Ruse (though it has become less popular in recent years), it is a silly mistake of feminists to suppose that their political commitments to women's liberation and sexual equality should or could have any influence on the practice of science or on the objects or facts of a natural science like biology.[19] Indeed, the whole project of sociobiology is, in effect, to show how the biological facts determine sociological realities, which undergird social norms (not vice versa).

If we take Ruse seriously, then not only can feminists contribute nothing to biology, but they can also expect to find the stories of female inferiority in our folk biology reified in scientific biology. What, after all, is more plausible than those 'facts' that one already knows? Moreover, though immune from normative criticism, biology still has normative import. While certainly it would be unfair to accuse sociobiologists of committing the naturalistic fallacy, they would surely endorse the commonsense principle that "ought implies can." If an individual cannot do other than x, then one cannot reasonably blame her for doing x. Insofar as biology reveals male and female human natures, it is politically naïve and morally indefensible to require people to go against these natures as they will inevitably fail. If biology is to be understood to be beyond normative criticism, despite having normative import, then feminists have no choice but to find accounts of feminist ethics and politics for which science is simply irrelevant rather than to legitimize accounts of human nature that will inevitably reify female inferiority.

Thus it appears that feminism is in a double bind: ignore biology at the price of losing a robust empirical basis for embodiment theory, which is one of the most important contributions that feminists have made to philosophy, or embrace biology at the price of potentially losing credibility for feminism without the possibility for reply. Ideally, feminists need a way of embracing biology without grabbing onto the oppressive. We want a way of getting rid of the patriarchal bathwater while keeping the biological baby.

DST offers a way out of this bind. Because it challenges nature/nurture and nature/culture dichotomies, DST effectively undermines the kind of approach to the fact/value distinction expressed in a Ruse-style separation of science and politics. DST does not turn this fact/value distinction on its head, but rather allows that it is a two way street. The common sense principle noted above, whereby biological facts influence values, remains but is supplemented by the insight that values influence biological facts, not merely superficially but profoundly. To see this, however, we first need a sense of the turn to development in biology and its particular expression in DST. We need to understand the power of DST before we can identify its promise.

ESSENTIALIST GENE-CENTRISM AND THE DST ALTERNATIVE

As the title of Keller's 2000 book announces, the twentieth century was *The Century of the Gene*. The past tense is important here as the twenty-first century promises to be the century of the rest of the organism and, perhaps, the entire developmental system. In her work Keller tells the story of gene-centrism through a feminist lens. Indeed, gene-centrism has been a central theme of feminist critiques of biology generally. Feminists have argued that the focus on the gene disappears the female body, characterizing it as nothing other than a mere vessel for gene-expression. Not merely the gestating body, but even the body of the cell gets disappeared from the analysis, as all is made into a vehicle for genes. The account is one of gene action in the face of the passivity of the cytoplasm and, indeed the pregnant female body. The account is essentialist and reductionist. The explanation of the organism and its traits is reduced to an account of genes and the evolution of populations through changes of gene distribution. The language of replicator and interactor is often used. Genes replicate themselves using the rest of the organism and environment in their battle for survival. The true account of the organism, its essence, can be read from its genes.

That this ontology of the gene has come to be recognized as suspect is perhaps unsurprising given its history. The concept of the 'gene' preceded the discovery of DNA by a number of decades.[20] Originally, the term stood as a conceptual placeholder for that which allowed the inheritance of traits across generations and explained why individual organisms have the traits that they do. Crucial for understanding life itself, the gene was conceived to be "an inherently stable, potentially immortal, unit that could be transferred intact across generations."[21] The modern synthesis of the early-to-mid twentieth century brought together Darwin's theory of evolution with the genetics of Mendel and the discovery of DNA. Developmental biology or embryogenesis was visibly left out of this synthesis.

Ironically, Keller cites the human genome project as a turning point away from gene-centrism. Thus the project that is perhaps the clearest expression of gene-centrism seems to be responsible, at least in part, for its demise. Once scientists had the complete sequence of human DNA they realized how uninformative genetic information was. As Keller writes:

> For almost fifty years, we lulled ourselves into believing that, in discovering the molecular basis for genetic information, we had found the 'secret of life'; we were confident that if we could only decode the message in DNA's sequence of nucleotides, we would understand the 'program' that makes an organism what it is. And we marveled at how simple the answer seemed to be. But now, in the call for a functional genomics, we can read at least a tacit acknowledgement of how large the gap between genetic 'information' and biological meaning really is.[22]

Functional genomics looks at gene expression and how gene products function under various circumstances. Features such as the timing of gene activation and the role of RNA in cell replication require going beyond the sequence alone and looking at how parts of the chromosome interact with the rest of the cell at different times. Thus functional genomics challenges the gene/cell dichotomy, making inheritance and trait development contingent on the interaction between the two.

In effect, DST extends the mainstream move away from reductionism and toward complex causes in biology, challenging all dichotomous thinking in biology. In DST the replication of chromosomes, cells, organisms, populations and even environments and cultures are viewed as complex and mutually informing. The gene is no longer given a privileged place as a master molecule that directs all other biological material in its own fight for survival and replication.

As Robert, Hall and Olson note, "Developmental systems theory is not so much a single theory as a set of theoretical and empirical perspectives on the development and evolution of organisms."[23] As a result a common way of characterizing the position is through listing central tenets.[24] Here I follow Russell Gray's list from "Feminism, Developmental Systems and Evolutionary Explanations," as he offers these with a view to explaining DST's implications for the sex/gender distinction. The first of the tenets, "*Joint Determinism,*" is perhaps the simplest and the most basic; "[a]ll phenotypes, be they physio-

logical, morphological, or behavioural, are jointly determined by both genes and the developmental context."[25] It is a consistent theme in DST that although all biologists now accept *Joint Determinism*, few fully integrate it into their science. More strongly, DST suggests that genes should not be given any kind of priority, so even the dichotomy suggested by talking of genes *and* the rest of the developmental context, should be rejected in favour of viewing genes as simply one of a set of resources that causally contribute to the construction of the organism. As explained above, a gene-centric, reductionist ontology is no longer viable, thus DST's demand that joint determinism must become a basic assumption of biological science is in a sense mainstream, even though it has not yet been adequately integrated into academic biology, and has little presence in folk biology.

The second tenet, "*Reciprocal and Temporal Contingency*," begins to unpack the profound implications of the first. The effects of genetic, phenotypic and environmental changes are contingent, each depending on the context that the others provide. In other words, the result of some chemical or stimulus in the environment of an organism may or may not alter the organism, depending on the genotype and phenotype of the organism; conversely a genetic mutation may or may not influence the phenotype and (indirectly) the environment, depending on the traits of the organism and features of the environment. That this contingency is sometimes temporal becomes apparent when one considers specific examples. For instance, the relevance of levels of folic acid in the blood stream is radically different depending on a human's stage of development; there is only a brief period of time where this can play a causal role in developing neural tube defects.

The concept of the reaction norm is illuminating. Reaction norms are the array of different developmental results that an organism might achieve depending on its environment, given its specific genetic and current physiological basis. No particular path in this array is the 'normal' path; each is 'normal' for the gene/trait/organism under those particular circumstances. So, for instance, species of live oak will keep their leaves throughout the year, except in the northern parts of their range where they will lose them. But a live oak in Virginia is no less an exemplary or flourishing live oak, "following its genetic code," than a live oak of Texas. Oak trees will develop along various different paths depending on all the various developmental resources at their disposal. Bonsai trees make the case yet more forcefully. Many different species can be used in this art, it is the developmental system of human cultivation that keeps them dwarfed, but given this environment it is *normal* for them to be dwarfed. There is no one model for the reaction norms of a gene or trait. David Hull usefully summarizes the many different possible forms of reaction norm:

> Some reaction norms are very narrow, i.e., in any environment in which the organism can develop, it exhibits a particular trait and only that trait. Sometimes reaction norms turn out to be extremely broad. A particular trait can be exhibited in a wide variety of states depending on the environments to which the organism is exposed. Some reaction norms are continuous; others disjunctive. Sometimes most organism [sic] occupy the center of the reaction norm; sometimes they are clustered at either extreme, and so on. Everything that could happen, in some organism or other does happen.[26]

This leads to the third tenet, "*Construction, Not Transmission*." It is tempting to "read" DNA as a genetic code that transmits information across generations. However, according to DST, "[d]evelopmental information is not in the genes, nor is it in the environment, but rather it develops in the fluid, contingent relation between the two."[27] Gray draws an analogy with literary texts. Just as strings of letters are intrinsically meaningless, so strings of alleles hold no information. The text needs reading for its meaning to emerge in the process of its being read and genetic material needs developmental resources for information to emerge through the organism's ontogeny. Like the many possible readings and re-readings of a text, the information that emerges through ontogeny is contingent as developmental results depend on developmental resources.[28] This tenet is perhaps most easily understood when considered in tandem with the fourth tenet, "*Expanded Inheritance.*" This states that offspring inherit more than just genes from their parents; they inherit the developmental system, including altitude, weather conditions, food sources, dangers, shelters, parasites, competitors, symbiotes and, for certain kinds of organisms, cultures. All these other developmental resources interact with the genes, physiology and the environment of the organism at different points throughout its life cycle. These multiple mutu-

al causes are typically inherited, generation after generation, and work together to construct the various traits of the organism. Thus the entire developmental system is responsible for transmitting information across generations.

As the fifth tenet, "*Co-Construction*," highlights, factors "internal" and "external"[29] to the organism are co-defining and co-constructing. Genes can only be *defined* as genes for a certain trait in a specific developmental context and *descriptions* of environments can only be given in organism-relative terms. Gray illustrates this through one of Lewontin's examples:

> For a bacterium in a pond, Brownian motion is a major environmental feature and gravity is not, whereas for a heron in the same pond, quite the opposite is the case….What are resources to one organism may be irrelevant to another. Any statement about resources limiting a particular population must be contingent upon a given range of actions by that population.[30]

Moreover, organism and environment are co-constructing. It is obvious that environmental resources play a crucial role in the construction of organisms—stop watering your plants and observe—but equally, organisms modify their environments. Gray's list of examples includes nests, dams, international banking systems and shedding leaves and bark.[31] These modified environments again may be part of the inheritance that is transmitted from generation to generation.

With the final tenet, "*Interactive Constancy and Repeated Assembly,*" Gray turns to inheritance and evolution and the stability with which traits are transferred across generations. He writes:

> Any adequate view of development must explain the remarkable developmental constancy that exists across generations (humans rarely have two heads). Dichotomous views of development achieve this by appealing to either the constancy of a preformed genetic program or to the constancy of the environment. However, just as in baking a cake using the same ingredients is not enough to guarantee a constant outcome (they must be put together in the right way), so too in development it is the constancy of process that counts.[32]

Natural selection does not, then, select for the fittest genes, but it selects for those developmental processes that are most successful in replicating themselves.[33] Indeed, within DST the organism is reconceived as a developmental process—"a series of interactions with developmental resources which exhibits a suitably stable recurrence in [a] lineage."[34]

Although DST challenges the traditional gene-centric model of evolutionary biology, it still retains many features from Darwinian evolution. Griffiths and Gray note that "the fundamental pattern of explanation—the development of complex form, through variation and differential replication—is preserved."[35] Moreover, though no longer seen as a battle between genes, competition also remains. In the terms of DST, competition occurs when two developmental processes use the same limited resources. However, DST also highlights the fact that much of the interpenetration of developmental systems is not competitive.

Finally, when one gives up a gene-centric ontology of life, it becomes impossible to separate the biological from the cultural. Any feature of social organization or culture for a certain population that is inherited by its members and that affects a member's capacity to survive and reproduce is simply another developmental resource. As Griffiths and Gray note, this does not seem in the least far-fetched in principle when one considers the importance of development to human psychology and behaviour. They write:

> The developmental systems view emphasizes the currently marginalized fact that humans have had a culture since before they were human. This culture is one of the developmental resources that feeds into the development of evolved traits….Many species-typical features of human psychology may depend critically on stably replicated features of human culture.[36]

Thus DST not merely rejects gene-essentialism, but emphasizes that this implies the rejection of nature/culture and nature/nurture dichotomies. Because no feature of the organism is given ontological primacy, each feature's development being interdependent with the rest, no feature is deemed biologically inevitable. Thus the very foundation of the theoretical framework that threatened to hobble any normative feminist theory that takes embodiment seriously is undone by DST.

It is worth emphasizing that to some extent the key ontological points of DST are not controversial. Even Richard Dawkins, perhaps the most famous proponent of gene-centrism, now maintains that gene-centrism is to be preferred *not* because it gives a true ontology but because it is methodologically superior. As Sterelny and Kitcher put it in their own defence of methodological gene-centrism, "There is no privileged way to segment the causal chain and isolate the (really) real causal story."[37] While *perhaps* a DST ontology will not make a difference to the practice of biology—in terms of experimental design and data collection—, it makes all the difference to its interpretation, the method of critique and the implications for society that can be drawn from biology. These are precisely the areas in which feminist theory has most to offer biology and has the most at stake in biology. It is the ontology of biological essences and nature/culture and nature/nurture dichotomies that DST effectively overthrows, and the promise of different ways of conceiving development and human being that DST offers.

FEMINIST USES OF DEVELOPMENTAL SYSTEMS THEORY

In undermining the ontological commitments of gene-centrism, DST can be seen to offer a powerful tool for feminist politics, but this ontology also has promise for feminist epistemology. As I explain in this section, because epistemic subjects are organisms and their cognitive and perceptual capacities are developed, DST has implications for analyses of the knowing subject that are consistent with feminist approaches to the subject. Moreover, the methods and norms of at least one important feminist approach to scientific epistemology, Helen Longino's, are well suited to investigating objects understood in terms of a DST ontology. Indeed, feminist biologist, Anne Fausto-Sterling, has used DST to ground an account of sex/gender/sexuality. I conclude this section by further articulating some of the implications for politics that follow. Through this analysis it will be seen that biology can be a powerful tool for feminist theorizing, forcing political discourse to address basic values and the real, material, embodied results of organizing societies around these values. Moreover, because it is not essentialist, DST holds out the possibility of real change and allows that many forms of social organization may be conducive to human flourishing.

Helen Longino has offered a model for a feminist successor science that has enjoyed considerable interest[38] and allows us to gain a sense of how DST might be a good candidate for a successor biology. Here I will show some of the continuities between DST and Longino's account of a more egalitarian and democratic approach to scientific knowledge and inquiry. I will argue that Longino's epistemology provides an account of knowers and the norms of scientific knowledge that can usefully be informed by DST, while also being conducive to successful science carried out on the foundation of a DST ontology. The idea is that DST and Longino's scientific epistemology are mutually strengthening, each giving grounds for accepting the other. Thus DST can be seen to be not merely consistent but coherent with feminist scientific epistemology.

Longino takes the standard feminist line in characterizing the individual knower as thoroughly situated. DST explains how this situatedness *can* be biological, embedded in the body, without evoking essentialist ideas of women or their "ways of knowing." When we recognize the knower herself as a biological object through the lens of DST—a physically and socially situated subject whose cognitive capacities are shaped by past experiences—we are forced to recognize that there is no one optimally functioning cognitive agent. Rather, variations in cognitive capacity are the result of variations in the developmental system (roughly, genes, phenotype and environment) and are likely to bring with them sets of interests that will attune a knower to features of an object under study. There are familiar and predictable examples of this—the prevalence of women in the field of developmental biology[39]—and also more surprising ones—the case of the biologist Temple Grandin, who claims that her autism has helped her to understand animal behaviour.[40] The lesson is not new, but again, in terms of DST the situatedness of the knower is seen as a biological rather than merely social fact, without being essentialized. Moreover, as a matter of biological fact, no specific "situation" can be adopted as "normal" (in anything other than a statistical sense), "truly human," or "objective."

Because we cannot identify specific individuals as exemplary knowers, Longino suggests turning the focus of epistemology onto the group, making the norms operating within the group regarding critique and assessment central to epistemic practice. Facilitating real critique that is capable of unveiling enshrined background assump-

tions, rooted in individuals' interests and perspectives, requires diversifying the community as much as possible and democratizing epistemic authority.[41] It is important to recognize that Longino's position is not thereby anti-empirical or arational. She explains,

> Equality of intellectual authority does not mean that anything goes but that everyone is regarded as equally capable of providing arguments germane to the construction of scientific knowledge. The position… holds that both nature and logic impose constraints. It fails, however, to narrow reasonable belief to a single one among all contenders, in part because it does not constrain belief in a wholly unmediated way. Nevertheless, communities are constrained by the standards operating within them and individual members of communities are further constrained by the requirement of critical interaction relative to those standards. To say that there may be irreconcilable but coherent and empirically adequate systems for accounting for some portion of the world is not to endorse relativism but to acknowledge that cognitive needs can vary and that this variation generates cognitive diversity.[42]

Thus Longino's account of the individual knower and her turn to social epistemology does not imply a pernicious relativism, but instead offers a realistic pluralism.

Just as DST provides a robust ontological basis for the variation between individual knowers, so Longino's epistemology provides a basis for understanding the possibility of science, given the multiple descriptions of a given state of affairs that, according to DST, may all be equally legitimate. Scientific communities are governed by their own sets of standards as to their proper objects and methods as well as basic norms of reasoning and nature itself. So, for instance, while ontologically it may be impossible to draw a line between the cultural and the biological, epistemically, specific disciplines can, indeed must, draw the distinction to make their investigations tractable, abstracting and idealizing the phenomena under study. Thus, for instance, both biologists and sociologists may investigate the dangers of human pregnancy, but a biologist might focus on the physiological significance of bipedalism and a sociologists might focus on the relative status of women in a particular group and their access to various support networks. To think that either investigation could offer the final facts about the dangers of pregnancy is to fail to recognize the multiplicity of causes affecting human functioning, in other words, the complexity of the developmental system. Hence, even if the distinction between the biological and social and thus the sex/gender distinction is ontologically fraught, the terms can still usefully demarcate certain causes studied by biologists from those studied by sociologists. In the case of studies assuming sex or gender categories, democratizing epistemic authority serves as a check on sexist background assumptions, and pluralism itself functions as a reminder of both the partiality and contingency of both sociological and biological accounts.

However, as Longino acknowledges, pluralism poses a serious dilemma: "if objectivity requires pluralism in the community, then scientific knowledge becomes elusive, but if consensus is pursued, it will be at the cost of quieting critical oppositional positions."[43] She concludes that consensus must be given up as a marker of scientific knowledge and with it any ideal account of knowledge as "absolute unitary truth." According to some accounts of scientific theories this would be tantamount to giving up on science, but Longino points out that the semantic (or model-theoretic) view of theories is able to accommodate it. Rather than understanding theories to be sentences that are true or false, the semantic view takes theories to be sets of models that have better and worse fit with some portion of the world. "Model" here has been read in any number of ways,[44] but each emphasizes that models have structures that fit a certain set of phenomena. What matters is not only that the relations that a model picks out are in the world, but also that they are the ones in which we are interested, so that they can guide our activity. Freed from an expectation of terminating in the truth, science becomes a practice. "Scientific knowledge from this perspective is not the static end point of inquiry but a cognitive or intellectual expression of an ongoing interaction with our natural and social environments."[45]

This seems an ideal approach to the biological objects understood through DST, as the expectation is that facts about any given species or population will not be fixed, but will be contingent upon multiple features of the developmental system. Giving up the search for a final truth in favour of accurate and predictive models is surely more con-

ducive to success in an ontology where there are no essences, but multiple mutually interacting, but contingent, causal processes the stability of which is itself contingent. Longino's epistemology, in the light of DST ontology, promises a less dogmatic science that must pursue objectivity through democratizing scientific communities and practices. DST offers a type of ontological commitment that promises not to undermine this epistemic pluralism.

So far I have characterized the promise of DST in its continuities with a model of a feminist successor science, but DST also promises to provide a robust biology without essences, undermining the nature/culture and nature/nurture distinctions. DST offers a way of doing empirically sound biology without essentializing male and female and the differences and variations between and among them. Feminists have long been aware of the tendency of cultural norms to be inscribed on or embedded in women's bodies. As Kathleen Okruhlik has pointed out, "Such 'physical givens' as height, bone density, and musculature are to a large extent determined by cultural practice."[46] DST places these insights into a broader theory.

Recently, DST has explicitly been used by feminists to challenge types of dichotomous thinking characteristic of those who believe in innate sex differences. In *Sexing the Body*, Anne Fausto-Sterling carefully lays out the various causal processes that play a role in the construction of sex/gender/sexuality, revealing the simplifying assumptions that tend to distort the scientific investigation of these closely related concepts. Of particular interest is the contemporary medicalization of intersexuality and its complicated relationship with heteronormativity. The "correction" of ambiguous genitals, assigning intersexed children their "true" sex, is an extreme example of DST's insight that culture affects biological construction. It is not simply the fact that our society values sex dimorphism and so literally constructs it, but also that social norms dictate what counts as being a "real man" and a "real woman." These themes are further explored in the contexts of neurological sex research and sex hormone research. Generally, Fausto-Sterling reveals the tendency of biomedical sciences to construct two-sex accounts of human functioning and, in the face of the diversity of sex/sexuality/gender expression, correct the human population to fit the dichotomous model, rather than fixing the model to fit the empirical facts. Through her careful scientific approach Fausto-Sterling dovetails contemporary biology with feminist attempts to destabilize gender and heteronormativity that are characteristic of Judith Butler's work (though similar ideas can be found in early second wave feminism).[47]

Fausto-Sterling finishes her book with a chapter on DST as a prolegomena for future "investigations of the process of gender embodiment,"[48] noting that "no single academic or clinical discipline provides us with the true or best way to understand human sexuality."[49] This is a restatement of Longino's pluralism in the context of the study of human sexuality. The existence of a trait of a particular organism may have multiple explanations from different sciences and different groups of scientists within them; and, so long as they are all empirically adequate, there appears to be nothing to choose between them. Indeed, they may all be right. Development along any particular path may sometimes be determined by many causal factors, or even over-determined. The tendencies of certain sciences (like molecular biology) to proffer simple unitary accounts are undone and recognized as neither plausible nor desirable.

Another way of making this point is by taking a close look at the ontological implications of the plasticity of reaction norms. Doing so reveals that there can be no robust notion of normality beyond the statistical, and undermines any attempts to draw implications for normativity out of a biological conception of normalcy. This, again, is not an insight that is limited to DST, but is implicitly endorsed by the turn toward development in biology generally. David Hull, in this discussion of "Human Nature" (1987) decisively rules out any sense of normalcy that might be used to define species essences and moreover any normativity that might rest on such a concept. This, he maintains, is not to rule out normative discourse as meaningless, but to point out that there is no biological given upon which normalcy can rest. We may have reasons for preferring one developmental path more than another, either directly or indirectly, but we choose the values upon which such reasoning is based in our religious and metaphysical discourse, our moral reasoning, and our political negotiations. They are not simply written in nature.

This is not to deny that ought implies can, but to recognize that, biologically speaking, our actions and dispositions are developed and could have been otherwise, given the right mix of developmental inputs at various points in our lives. If one wants to change the distribution of a given trait in a population, the task is not to overcome nature but to rearrange the developmental system. This is never a trivial matter as, due to Co-Construction, not merely will the new

trait possibly affect aspects of the organism's developmental system (including other traits of its own and the environment), but the change to the developmental system, prompting the trait change, is likely to affect the developmental system of other organisms and the target organism (directly and indirectly). The normative question here is whether the whole set of changes related to the target trait and the unforeseeable risks that inevitably accompany them are preferred over the current state of affairs.

DST implies that even when hierarchies and sex/sexuality differences are biological, and in this limited sense "natural," they are in no way inevitable. For any organism, its current morphology and behaviour is a result of its developmental system. Though they may not be currently or historically instantiated, there are an array of different possible developmental systems wherein the morphology and behaviour of the organism would develop differently and these contexts would be no less "biological" or "natural" for emerging through a different developmental path. In principle, any trait or form of social organization can be molded by changing the developmental system. Thus DST implies the potential to guide transformations of the world according to political values, such as the feminist goals of meeting human needs and supporting universal empowerment. Moreover, DST shows us that this social project is one that must be empirically informed through knowledge of the real biological systems within which individuals live and thrive. Embracing this biology, however, no longer runs the risk of reifying the sexism of the past, for there are no facts about male and female essences to be discovered. The focus is nonetheless still realist; discovery and critique revolves around real, but complex, causal processes that can be modeled through various sciences, depending on various interests. Thus DST suggests that profound changes to the very forms of human life are possible, if fraught with potential dangers.

CONCLUSION

In this paper I have tried to show the power and promise of DST for feminist philosophy. I have only addressed a fraction of the potential for this alliance, which I think offers the possibility of a wide-ranging and integrated ontology, epistemology and politics that builds on feminist insights and is conducive to feminist ends. While certainly past feminist suspicion of biology was justified, recent advances in the field show that the old biological essentialism and accompanying dichotomies are hopelessly flawed and empirically false. DST extends these insights, placing them at the heart of biological theorizing. Rather than a master molecule dictating the evolution of species and the development of individuals, multiple developmental resources are seen as the interacting processes that make up the organism. Furthermore, a robust DST ontology is already consistent with some of the projects of feminist epistemology and has grounded a perceptive analysis of a central topic of feminist theory, the sex/gender distinction. Through the lens of DST, the performances of gender identity and the lived embodiments of sex identity are understood as mutually informing and contingent, shaped by the social and physical conditions of human organisms and their environments. Because humans shape our social and physical environments, how sex /gender/sexuality exists among humans is, in significant part, a result of our own making and could be otherwise. Tendencies to essentialize sex/gender dichotomies cannot withstand the robust biological analysis of the multiple causal processes (the complex developmental system) involved in the construction of sex/gender identities.

Feminists of all stripes have always been interested in constructing a just society that supports human flourishing. Moreover, with the focus on the relational self in ethics and theories of identity, feminists have shown a growing appreciation for the complex interdependencies that characterize human life and complicate human agency. What DST reveals is that these are thoroughly biological projects and what counts as human flourishing, though thoroughly biological, cannot be separated from the rest of the developmental system or the values that we bring to our theories of life.

NOTES

1 I would like to thank the Philosophy Department at Dalhousie University (particularly, Duncan MacIntosh) and members of the Evolution Studies Group for their useful comments on an earlier version of this paper. Thanks also to the editors of this volume for their generosity, guidance and patience, an anonymous reviewer for her helpful comments and to May Yoh for her careful reading.

2 The title is borrowed from Karen Warren's "The Power and Promise of Ecological Feminism" (1990).

3 A recent example is the reporting of Gerianne Alexander's findings that juvenile male vervet monkeys like playing with boys' toys—cars and balls—while little female monkeys prefer to play with dolls and pots. According to the reported study, the preference shown for gender neutral toys—books and a plush toy dog—was equal. This was taken to show that essential, sexually dimorphic play preferences go back 25 million years in humans' evolutionary past (the time of our shared ancestor with vervets). My point here is not the inadequacy of the research, which is an important but distinct issue, but the fact that it was widely reported with little or no critical analysis, despite its prima facie implausibility (such as suggesting as an explanation that female vervets recognize dolls (in preference to toy dogs) and pots as "opportunities for nurturance" (Gerriane Alexander and Melissa Hines, 2002, "Sex differences in response to children's toys in nonhuman primates (Cercopithecus aethiops sabaeus)." pp. 467–479.), their own admission of not controlling for a possible obfuscating factor, namely object colour (*ibid*., p. 475) and their ardent adaptationism (a term I borrow from Elisabeth Lloyd, 2005, p. 176)). For instance, an article by Robert S. Boyd was published in many of Knight Ridder newspapers with various different headlines. Boyd links Alexander's study with another that reports brain differences between human males and females—men putatively have more grey matter and women have more white matter in the relevant areas—which were, predictably, associated with gender differences in information processing. The headlines include, in *The St. Paul Pioneer Press*, "NATURE, NOT NURTURE; New Technologies and experiments make a case that sex-linked behaviours spring from differences in the structure of the brain"; in *The Fort Worth Star Telegram*, "Gender [sic] affects monkeys' toy choices, study says." The story was also picked up (though edited) by *The Edmonton Journal* and *The Montreal Gazette* as "Toys a boy/girl thing for apes [sic], too: Monkeys' choices mirror human stereotypes, research finds" and "With monkeys, boys will be boys: study: Males dig cars, females like dolls; As in humans, gender differences show up in toy preferences," respectively.

4 Donna Haraway, 1978, pp. 21-36; Nancy Tuana 2004, pp. 220-4; Elisabeth Lloyd, 2005.

5 Russell Gray tells a similar story of the feminist turn from evolutionary biology (Russell, 1997, pp. 385-6).

6 By ontology I mean the basic theoretical characterization of the objects of biological investigation. Here I only address DST as an ontology, as opposed to a methodology. I think the question of whether DST can ground a successful research programme, is actually far more difficult.

7 Though I focus my discussion on evolutionary biology, it is worth noting that key features of this sub-discipline pervade all biology. Perhaps most relevant are the ideas of function and fitness. These ideas are embedded in the evolutionary account of organic life: generation after generation certain organisms have certain heritable traits that better perform a function making the organism fitter, i.e., more likely to survive and/or reproduce than its conspecifics. Traits have functions, or so the orthodox story goes (this, though a serious oversimplification (see Stephen Jay Gould and Richard Lewontin, 1979, pp. 581-598), is true much of the time), and a trait's fulfilling its function makes the organism fitter, ceteris paribus.Indeed, even those who dispute evolution do not dispute that function and fitness are features of organic life. The point is, whether deigned by God or natural selection, the traits of organisms are understood to exist for a reason.

8 Virginia Held, 1990, pp. 321-329.

9 For instance, Carol Gilligan, 1982; Joan Tronto, 1993; Susan Moller Okin, 1989.

10 For instance, Sandra Harding, 1991; Patricia Hill Collins, 2000; Lorraine Code, 1991.

11 See Elizabeth Spelman, 1982.

12 See, for example the critique of traditional theories of autonomy in Susan Sherwin, 1998, 24-34. Londa Schiebinger opens her edited anthology,

Feminism and the Body, in a way that emphasizes the importance of feminist theory in the turn to the body. She writes, "In the 1970s, feminists reinserted the body into history bringing to light issues that had previously been considered too vulgar, trivial or risqué to merit serious scholarly attention" (Schiebinger, 2000, 1). What is true for history must surely be doubly so for philosophy.

13 See, for instance, Sarah Blaffer Hrdy, 1981/1999, p. xxvii.

14 See the Biology and Gender Study Group, 1988 and Elisabeth Lloyd, 2005.

15 See also Londa Schiebinger, 2000, p. 9.

16 Elisabeth Lloyd, 2005.

17 Sarah Blaffer Hrdy, 1981/1999, p. 1.

18 Michael Ruse, 1981, pp. 235-6.

19 John Maynard Smith, 1998, pp. 381-2, especially and Susan Haack 2003. I do not use the original references here, but rather the anthologies as I think it significant that, although both Maynard Smith and Haack show a remarkably poor understanding of the views that they attack, they have been anthologized in important introductory textbooks in philosophy of biology and epistemology respectively. See Schiebinger quote in note 12 also.

20 Evelyn Fox Keller, 2000, pp. 1-3.

21 *Ibid*., p. 14.

22 *Ibid*., p. 7.

23 Jason Robert, Brian Hall and Wendy Olson, 2001, p. 954.

24 Though the tenets often tend to differ somewhat in detail they remain the same in overall effect (see, for example, Robert, Hall and Olson, 2001, 954-956; Oyama, Griffiths and Gray, 2001, 1-6).

25 Russell Gray, 1997, p. 391.

26 David Hull, 1986, p. 8.

27 Russell Gray, 1997, p. 393.

28 *Ibid*., pp. 393-4. I have considerable misgivings about the use of the term "information" in this context, but as I know of no better term to fill its explanatory function, I follow Gray's use.

29 These are Gray's scare quotes; he points out that the notions of "internal" and "external" ultimately become useful fictions from the perspective of DST.

30 Russell Gray, 1997, p. 395.

31 *Ibid*.

32 *Ibid*., pp. 395-6.

33 See P. E. Griffiths and R. D. Gray (1994) for a more complete account of evolution seen through the lens of DST.

34 P. E. Griffiths and R. D. Gray, 1994, p. 292.

35 *Ibid*., p. 300.

36 *Ibid*., p. 302.

37 Kim Sterelny and Phillip Kitcher, 1998, p. 171. Here they also offer an account of Dawkins' change of heart on this issue.

38 See, for instance, Elisabeth Lloyd, 2005.

39 Evelyn Fox Keller, 1997, pp. 18-9.

40 Temple Grandin and Catherine Johnson, 2005.

41 Helen Longino, 1993, pp. 111-2.

42 *Ibid*., p. 113.

43 *Ibid*., p. 114.

44 For example, Bas van Fraassen, 1980 and Margaret Morrison and Mary Morgan, 1999.

45 Helen Longino, 1993, p. 116.

46 Kathleen Okruhlik, 1998, p. 198. Indeed, there are many familiar examples, like the change of average height in a population accompanying a change in diet or correlations between women's access to economic independence and birthrates.

47 In both *Gender Trouble* and *Undoing Gender*, Butler attempts to destabilize or "denaturalize" gender by revealing its contingency and identifying it as performance rather than essence. In doing so she hopes to legitimate and make intelligible bodies and ways of being that have been regarded as false or unreal. Although she follows a tradition of troubling sex/gender dichotomies that goes back to the early second wave (e.g., Shulamith Firestone, 1970 and Marilyn Frye, 1981, pp. 30-8), Butler is at pains not to reify ideas of the female grounded on sexual dimorphism or a myth of lost matriarchy that has, in some cases unfairly, been associated with the second wave.

48 Anne Fausto-Sterling, 2000, p. 235.

49 *Ibid*.

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