Sex as a Biological Kind:
A Case of Strategic Conceptual Engineering

by

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Abstract

This dissertation is a novel application of conceptual engineering that intersects the history and philosophy of science, metaphysics, value theory and metaphilosophy. It argues for the dual thesis that human sex is a biological kind and that humans are in need of a new sex concept. This dissertation offers a metaphysical account of sex as a biological kind, arguing that sex development is an emergent biological process. It also takes a conceptual engineering approach to sex as a concept, advocating for a new concept of sex decoupled from gender. This new sex concept is called 'nonbaptismal sex,' which ascribes sex in terms of ranges of properties and their relations. This concept is deflationary and is engineered to satisfy social and epistemic aims. I contrast my deflationary view of sex with what I call 'strong biological realist' and 'strong social constructionist' views. I take a moderate realist/moderate social constructionist view. In so doing, I contend that although sex has an unequivocal biological basis, sex is both constituted and caused by biological and social properties and relations that have *real* effects. This dissertation contains six chapters. Chapter I surveys kinds of kinds, particularly natural kinds and social kinds, in order to situate my claim that sex is a biological kind. Chapter II offers my analysis of biological kinds where I specify how their biological features interact with social features. Chapter III provides a conceptual history of the biology of sex. Chapter IV presents and critcizes what I call the 'layer cake' model of sex development. Chapter V offers my account of sex as a biological kind. Chapter VI presents my nonbaptismal sex concept for social and epistemic aims. This dissertation aims to show that sex exists independently from gender and both can and should be conceptualized differently for ameliorative purposes.

Preface

This thesis is an orginal work by Esther Rosario. Small pieces of Chapters IV and V will be published in Esther Rosario, "Sex and Gender,"(forthcoming) in *The Routledge Handbook of Essence* edited by Kathrin Koslicki and Michael J. Raven. Some of the research in Chapter II is derived from Ingo Brigandt and Esther Rosario, "Strategic Conceptual Engineering for Epistemic and Social Aims," *Conceptual Engineering and Conceptual Ethics* (2020) Eds. Herman Cappelen, David Plunkett, and Alexi Burgess. Oxford: Oxford University Press.

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Introduction

This project sets out to answer the questions: *What is sex? What is the relationship between sex and gender… is there, in fact, a sex/gender distinction?* and *How should we think, talk and act with respect to it?* I am motivated to engage with these questions in order to address our current cultural-legal conundrum about what sex is. This conundrum implicates recent policies and legislation in the US and elsewhere that putatively restrict access to social goods and services on the basis of "sex at birth"[1] as well as the need for morally and epistemically sensitive and responsible discussions about gender-affirming health care for youth (Twohey and Jewett 2022). In my estimation, current policy controversies are a continuation of a long-standing and inherited cultural preoccupation with sex differences and their purported social, psychological and behavioural influences (Fine 2010; Mikkola 2022). I am interested in addressing this conundrum for theoretical and practical reasons as it impacts our knowledge and physical, moral and social lives. I shall address these issues by undertaking a two-pronged philosophical approach that aims to uncover the nature of sex from a developmental perspective and how we as members of moral, social and linguistic communities should act, think and talk

[1]Sixteen states in the United States considered legislation that would restrict transgender individuals' access to public restrooms, locker rooms, and other facilities. On March 23, 2016, the state of North Carolina signed into law the **Public Facilities Privacy & Securities Act** (**HB2**), which mandated that individuals must only use restrooms or locker rooms that correspond to the sex identified on their birth certificates in government or publicly funded buildings. On May 30, 2017, the state legislature reached a compromise (**HB142**) on the original bill, but the new legislation prohibits municipalities from regulating private employment or public accommodations, including non-discrimination protections for trans and gender non-binary individuals (Stern, *Slate* 2017). In 2018, the Trump Administration considered narrowly defining gender based on a determination of genital presentation at birth—this was a proposal to define gender based on an application of the genital sex concept. Under the Trump Administration, the Department of Health and Human Services seeks to adopt a legal definition of sex and gender that defines sex as either male or female, immutable and determined by the genitals that a person is born with. According to this proposal, should there be disputes about the genital presentation of an individual, genetic testing for chromosomal sex will then be said to determine the sex/gender of a person (Green et. al, 2018).

about sex. My dual approach features an investigation in the metaphysics of science and feminist metaphysics and employs strategic conceptual engineering for moral, social and epistemic aims.

Drawing on Asya Passinsky's (2019) Finean framework for feminist metaphysics, I offer a real definition of sex that is sensitive to theoretical and practical interests. Within a Finean metaphysical framework, debates over what sex is are just debates about sex's real definition. A real definition specifies an entity's non-modal constitutive essence (Fine 1995; Koslicki 2013, 2018, forthcoming; Passinsky 2019). The real definition of sex I'll offer in Chapter V states that the biological properties of sex development are sex's only constitutive properties, and thus, sex's only essential properties. This real definition classifies sex as a biological kind. At first glance, offering a real definition of sex as constitutively biological yet adopting a conceptual engineering approach for normative aims may seem incompatible. My account, however, leaves open that there may be more than one real definition of sex. For example, one may wish to offer a real definition based on sex development across plant and animal species or a real definition of sex from the perspective of evolution, which would focus on sexual reproduction rather than organismal development. In either case, the theoretical and contextual interests involved in offering these real definitions and unpacking their explanatory roles would differ. Theoretical and practical aims frame the questions we ask including naïve metaphysical questions such as "What is sex?" My adoption of Passinsky's Finean framework enables me to specify what essentially constitutes sex from the theoretical lens of development while also being able to openly acknowledge the normative aims that guide my inquiry.[2]

[2] Mari Mikkola (2015) argues that feminist theoretical aims, such those espoused by Elizabeth Anderson (1995), are at odds with metaphysical inquiry since prevailing meta-metaphysical views assume that metaphysical inquiry is value-neutral. I endorse Passinsky's (2019) objection to Mikkola's worry over the value-neutrality of metaphysics.

In short, my answers to the questions above are that sex is a biological kind[3] and that it is distinct from gender. My metaphysics of sex differs from previous approaches (Ásta 2011, 2018; Butler 1993; Griffiths 2020; Khalidi 2021) insofar as my account moves beyond what I call 'strong social constructionist' accounts (Ásta 2011, 2018; Butler 1993) and evolutionary-based accounts (Griffiths 2020; Khalidi 2021). My metaphysical account is novel in two ways. First, it takes a developmental rather than an evolutionary perspective. This means that my project investigates what sex is in terms of the properties and relations of the growth and development of human organisms rather than the evolutionary role of gamete production.

Second, I maintain that sex has constitutive biological features that depend on the dynamic emergent process of sex development. Ultimately, I offer a novel metaphysical account that specifies sex's constitutive biological features and its causal features, which I argue are biological and social.

Moreover, I take a strategic conceptual engineering approach to offering a new concept of SEX[4]. My new concept is informed by my metaphysical account. Conceptual engineering is a philosophical methodology that enables us to revise or reject a current concept if it is not suitable for our theoretical or practical goals. Conceptual analysis allows us to clarify our current concept through reflection, but conceptual engineering enables us to do innovative theoretical or practical work by bringing a new concept to bear on explaining or addressing phenomena that might otherwise remain obscured, ignored or unadjudicated. There can be normative benefits to adopting a novel concept for a target community or individual, and these benefits serve to motivate the development and implementation of the new concept. An example of conceptual engineering in practice is the revision of the concept of MARRIAGE to encompass partnerships

[3] In Chapter II, I'll contend that like many biological kinds, sex is a socially significant biological kind.
[4] I'll use 'SEX' to refer to the concept and 'sex' to refer to the kind under metaphysical study.

among those of any sex or gender including same-sex couples (Pollock 2020). In revising our concept of MARRIAGE beyond heterosexual couples, the LGBTQ+ community benefits from having the option to marry since legally recognized marriage provides persons with more access to social goods such as improved access to healthcare and improvements in health outcomes. The benefits of a sex/gender inclusive concept of MARRIAGE are moral, social, political and economic for the target community, and benefit the larger society socially and economically.

To draw a contrast, conceptual engineering in the MARRIAGE case broadens the content of the concept MARRIAGE, but for this project I propose revising the concept of SEX with the strategic aim of restricting our use of the concept to primarily biomedical and scientific research contexts. Strategic conceptual engineering involves the development of a concept for a particular thought and action context and can be involve implementing additional concepts for other theoretical or practical goals (Brigandt and Rosario 2020). In the case of SEX, my strategic approach aims to provide an explanatorily useful concept, but one that also aims to minimize or eliminate the social evocations that tend to come with using what I'll call a 'baptismal'[5] SEX concept. I am concerned with minimizing or eliminating the use of baptismal SEX in these contexts because the use of such a tends to obscure factors relevant to social contexts and persons' moral lives. Those factors include the social, psychological and historical aspects of gender. In the end, I'll maintain that using a baptismal SEX concept in social contexts (and possibly *any* sex concept that anchors gender in sex) facilitates a type of initiation into a faith-based conception of gender. For this reason, I refer to my novel SEX concept as 'nonbaptismal.' Nonbaptismal SEX is a deflationary concept geared towards ameliorating social attitudes and

[5] By 'baptismal,' I mean a concept of SEX that has a quasi-religious social function.

practices about or related to biological sex. In what follows, I'll offer a brief synopsis of the work I engage in each chapter of this project.

In Chapter I, I explicate some of the kinds literature in order to situate my account of sex as a biological kind. I begin with surveying the literature on so-called 'traditional' natural kinds and the Putnam-Kripke view. I'll contrast this account with Homeostatic Property Cluster (HPC) kind theory. Later in this chapter, I shall examine how the HPC view falls short. Next I'll review Ian Hacking's (1999) theory of interactive kinds and Sally Haslanger's (2003, 2005, 2012) account of social kinds. Hacking offers a causal theory of interactive kinds that has a descriptive aim while Haslanger offers a constitutive theory of social kinds that has an ameliorative aim. Lastly in Chapter I, I briefly introduce the Finean non-modal account of essence that I'll apply to my analysis of sex as a biological kind.

In Chapter II, I offer my analysis of biological kinds where I specify how their biological features interact with social features. Most biological kinds are influenced by social features of some type depending on the organism or biological system in question; I call these 'socially significant' biological kinds. My analysis of biological kinds in this sense departs from Hacking's interactive kinds because I do not hold that self-awareness is integral to causal-looping. In this chapter, I present several examples of biological kinds and discuss their interactive social features. In this chapter, I also unpack the relationship between metaphysical inquiry and conceptual engineering.

In Chapter III, I provide a conceptual history of the biology of sex. In so doing, I examine historical and contemporary literature on the biology of sex spanning the early twentieth century to the present. In particular, I'll focus on research in genetics conducted by early twentieth-century researchers Thomas Hunt Morgan and Richard Goldschmidt who both endorsed a

molecular model of sex, which held that hormonal and genetic factors play a coequal role in sex determination and development. I'll also draw on research from Frank R. Lillie, who endorsed a hormonal model of sex development that relies on genetic information. I'll show how Lillie's hormonal model anticipated some contemporary views of sex development, which demonstrate that sex development is determined by more than genes alone. Furthermore, I'll examine the shift from classical to molecular genetics in the twentieth-century, and discuss the rise of the (molecular) chromosomal sex concept and its contemporary applications. This chapter offers a causal analysis of sex development and outlines explanatory approaches beyond those from molecular genetics. In the end, I argue that trajectories in sex development are multiply realized.

In Chapter IV, I present what I call the 'layer cake' model of sex development, which I attribute to psychologist Simon Baron-Cohen's (2003) and geneticists Francisco J. Sánchez and Eric Vilain's (2010) accounts of sex development in gender-based brain studies. I argue that the layer cake model is conceptually flawed and discuss Daphna Joel's (2012) alternative model to sex development, 3G sex, and I highlight the importance of epigenetics in accounting for the causal features of the process of sex development.

In Chapter V, I offer my account of sex as a biological kind. In so doing, I provide an analysis of sex's causal and constitutive features. I present my thought experiment *Sex on a Desert Island* to motivate my analysis that sex has constitutive biological features but not constitutive social features. After I present my preferred real definition of sex, I then expand my analysis of the causal features of sex development which I argue are best understood in terms of a dynamic emergent process. I draw on Sandra Mitchell's (2012), Jessica Wilson's (2021, 2015) and Mark Bedau's (1997, 2003, 2008) accounts of emergence to build my case that sex's causal features, from a developmental perspective, are weakly emergent. I also contrast my causal and

constitutive accounts of sex. The target of my metaphysical account is to demonstrate that sex's social properties *can* be deflated.

In Chapter VI, my task is to show that sex's social properties *should* be deflated for normative reasons. I argue that human sex labelling practices, such as the legal and cultural practice of sex assignments, have a normative 'baptizing' function rather than one that describes biological properties. Further, I argue that this 'baptizing' function actually targets a gendered economy of goods and services rather than describes biological sex. To address this issue, I offer my deflationary nonbaptismal SEX concept, which is meant to shed light on sex from the lens of development as merely a feature of human development, rather than a social and personal commitment to a particular gendered way of life. I draw on Sari van Anders' (2014) analyses of bio/logics to support my case for strategic conceptual engineering.

My constitutive analysis of sex goes beyond conferralist accounts by offering a Finean real definition. And in addition to arguing that sex development is a dynamic emergent process, my causal analysis offers an intersubjective "personal faith" dimension to Hacking's account of causal construction for interactive kinds. Sex assignments serve as an entry point into a gendered economy of goods such that "recensions of faith" (transgressions of gender-coding), e.g., having a non-binary, trans, agender, a non-normative cis identity, function as a betrayal of *what it is* to be a human among others and the relevant affordances (social goods and services).

Chapter I: Kinds, Construction and Real Definition

> Now, these classes, distinguished by unknown multitudes of properties, are not solely by a few determinate ones—which are parted off from one another by an unfathomable chasm, instead of a mere ordinary ditch with a visible bottom … but where any class differed from other things by an infinite series of differences, known and unknown, they considered the distinction as one of kind, and spoke of it as being an essential difference…
>
> John Stuart Mill *A System of Logic* (I.VII)

1. Introduction

What is it to be a *kind* of thing? What makes something what it is? Philosophers have engaged with these questions stretching back to at least Aristotle.[6] In order to motivate my examination of sex as a kind, I'll survey some of the literature on kinds. Kinds are categories or taxonomic classifications of objects that may be sorted together on the basis of having some properties in common (Khalidi 2013; Koslicki 2008). It is important for me to consider the kinds literature because in ordinary discourse it is often assumed that there is something fixed about sex categories—that one is either *female* or *male*. What is often packed into those assumptions is the idea that *female* and *male* are distinct kinds.

This chapter will investigate the differences between so-called traditional natural kinds, biological kinds and social kinds in order to set the stage for my analysis of biological kinds in the next chapter. In Chapter V, I'll argue that sex is a biological kind, but prior to doing so, I'll unpack my analysis of biological kinds in Chapter II. And in order to meet that task, in this chapter, I'll present key differences between traditional natural kinds, biological kinds and social kinds. Each of these kinds have rich literatures, but I shall survey the literature most relevant to my interests for identifying their boundaries. Aside from preparing a theoretical map to help reach my positive metaphysical claim that sex is a biological kind, surveying some of the kinds

[6]Including Aristotle's discussions in the *History of Animals* and the *Posterior Analytics*.

literature is also useful for unpacking underlying assumptions (e.g., about what is natural) and implications (e.g., about what is normal) involved in the ways we categorize sex through our institutions and practices, which I shall address further in Chapters IV, V and VI.

2. Natural Kinds

There is a rich and diverse literature on natural kinds, but I am only be able to survey some of that literature. The notion of a natural kind stems from three sub-disciplines: metaphysics, the philosophy of language and the philosophy of science. Metaphysicians are typically interested in the questions of what a natural kind *is* and whether these kinds have intrinsic and necessary essential features. On the other hand, philosophers of language are usually concerned with questions regarding the semantics of natural kind terms, such as whether natural kind terms function as names or descriptions. Lastly, philosophers of science tend to be interested in the natural kinds featured in the special sciences, and whether or how the kinds that feature into the best available scientific theories fulfill metaphysician's theories of natural kinds.

The division of objects into kinds can be traced back to Aristotle. And since at least Aristotle, some approaches to natural kinds favour the view that essential properties are those properties that enable the grouping of natural kinds. John Stuart Mill, by contrast, offers an anti-essentialist view of natural kinds. In *A System of Logic*, Mill examines Aristotelian approaches to kinds and asks whether it is a mistake to consider "some of the differences which exist among objects as differences *in kind*… and others only as differences in the accidents?" (1843, 78). Mill rejects the Aristotelian notion that kinds have essences. Mill, however, does maintain that natural kinds do not exist due to naming conventions, but rather, exist due to real divisions in nature. He describes these real divisions as "radical distinctions in the things themselves" that are "made by nature," rather than human "convenience" (1906 1.7:79-80). For

natural kinds theorists including Mill, natural kinds are contrasted with nominal kinds. Natural kinds are thought to reflect something about the way the world *is* outside of human naming conventions, activities and interests. In other words, natural kinds are typically considered to be rooted in the objective features of the natural world and thus mind-independent, i.e., where the existence of natural kinds is not dependent on human thinkers or perceivers. Mind-independence here also implies that human perceivers can be wrong about the characteristics of natural kinds and which objects count as kind members.

Natural kinds are also held to licence inductive inferences, to be featured in the laws of nature, and to play a role in causal explanation (Mill 1843; Koslicki 2008). For this reason, many natural kinds are deemed to be discoverable by the sciences. Chemistry offers a number of classic examples of natural kinds such as water is H_2O or the element Gold is Atomic number 79 (Kripke 1980).[7] Some approaches to natural kinds favour the view that essential properties are those properties that enable the grouping of natural kinds (Khalidi 2013). Essentialists about natural kinds tend to fall into the so-called traditional camp of views about natural kinds. On this view, all members of a natural kind are held to have the same characteristic properties, which enables universal generalizations like laws of nature, e.g., salt is soluble in water. Further, the essence of a natural kind metaphysically is taken to determine its identity and boundary, and the essence is thought to be epistemologically important because it explains the characteristic properties of its kind, e.g., the essence of sodium chloride (salt) is its positive sodium ions bonded to negative chloride ions (Brigandt 2009). There is not a consensus among essentialists as to which particular qualities delineate natural kinds. Instead, according to Muhammad Ali

[7] Some natural kinds might be humanmade (such as sucralose), but whether synthetic chemical kinds are natural kinds is open for some debate.

Khalidi (2013) essentialists about natural kinds typically take all or some of these properties to be characteristic:

(1) properties that are necessary and sufficient for membership in the kind
(2) microstructural properties
(3) intrinsic properties
(4) modally necessary properties
(5) properties that are discoverable by science (Khalidi 2013).

Given this list of candidate essential properties, one can see why chemical compounds serve as classic examples of natural kinds.

2.1. Traditional Natural Kinds

Hilary Putnam's (1962) and Saul Kripke's (1980) influential work on *a posteriori* necessary truths[8] helped to establish the notion that natural kinds have necessary properties that are discoverable by empirical investigation. Their work on natural kinds is commonly referred to as the 'Kripke-Putnam' view of natural kinds[9]. In addition to considering the essential chemical properties of water, Putnam and Kripke reflect on the conditions under which cats are necessarily animals. Putman (1962) compares the statement 'cats are animals' to 'bachelors are unmarried' and concludes that 'cats are animals' is "less necessary" than the analytic statement 'bachelors are unmarried' (1962, 660). On his line of thought, the former statement is "less necessary" because for cats the world could have turned out otherwise (cats could have been automata, or evolution might have produced a different animal similar to, but not the same as, cats) (Putnam 1962, 660). Kripke (1980) offers a more adequate analysis of the notion of *a posteriori* necessity. Kripke (1980) argues that the difference between 'cats are animals' and 'bachelors are

[8] *A posteriori* is an epistemological notion, which concerns how we come to know that something is true. An *a posteriori* truth requires that we go into the world and investigate, whereas an *a priori* truth only requires reflection. *Synthetic* is a semantic notion, which concerns the meanings of words. A synthetic truth is not true due to the meanings of words. An *analytic* truth is true in virtue of what the words in a statement mean.
[9] Kripke (1980) notes that he and Putnam came to their conclusions about the necessity of statements like 'cats are animals,' independently.

unmarried' is that the former is found to be true through empirical investigation, whereas the latter is true by virtue of reflecting on the meaning of the word 'bachelor' (122-126, 138-140). The former, 'cats are animals,' is a necessary synthetic *a posteriori* truth and the latter, 'bachelors are unmarried,' is a necessary analytic *a priori* truth. The former's truth conditions depend on uncovering something about the way that the world is, while the latter's truth conditions depend on the meaning of words.

According to Kripke (1980), scientific investigation is able to discover the *essence* of natural kinds, which are necessary properties known by experience rather than reflection. What the Kripke-Putnam view of natural kinds contributed was not only a new way to think about necessity, but an essentialist framework for considering the boundaries of natural kinds. On this line of thought, what makes natural kinds unique is that they have an essence that is discoverable by empirical investigation. This essence is intrinsic, e.g., the microstructure of gold. Gold has its chemical microstructure essentially even though empirical work is required to determine what individual samples of gold actually consist of. He argues:

> …we use [the term] 'gold' for a certain *kind* of thing. Others have discovered this kind of thing and we have heard of it. We thus as part of a community of speakers have a certain connection between ourselves and a certain kind of thing. The kind of thing is *thought* to have certain identifying marks. Some of these marks may not really be true of gold. We might discover that we are wrong about them. Further, there might be a substance which has all the identifying marks we commonly attributed to gold and used to identify it in the first place, but which is not the same kind of thing, which is not the same substance … it is not gold. Such a thing is, for example, as we well know, iron pyrites or fool's gold. This is not another kind of gold. It's a completely different thing which we discovered and called gold. We can say this not because we changed the *meaning* of the term gold, and thrown in some other criteria which distinguished gold from pyrites … On the contrary, we *discovered* that certain properties were true of gold in addition to the initial identifying marks by which we identified it. These properties, then, being characteristics of gold and not true of iron pyrites, show that the fool's gold is not in fact gold (1980, 118-119).

For Kripke, when we come to the realization that fool's gold is not gold, the meaning of the word 'gold' does not change, but rather, through empirical work we discover the essence of gold such that any substance that contains that essence is necessarily gold in any state of affairs (i.e., possible world).

Moving away from the language focus of Gottlob Frege's (1892/1948) and Bertrand Russell's (1905) accounts of names as definite descriptions, Kripke contributes a metaphysical analysis of what objects like gold and water *are*, rather than what the terms 'gold' and 'water' mean. This analysis combines an *a priori* truth about a given natural kind essence (i.e., to be a natural kind member is to have a particular essence) with the empirical details of the kind's essence (that is only knowable *a posteriori*). It is worth noting that not all theories of natural kinds feature essential properties (Tahko 2015), and although philosophers such as Brian Ellis (2001, 2002) have worked to revive the Kripke-Putnam view as 'scientific essentialism' and 'the new essentialism,' homeostatic property cluster kind theory is a scientifically-focused alternative theory of natural kinds that does not ascribe essences.

2.2 HPC Kinds

Following Kripke and Putnam's contributions to realism about natural kinds, philosopher Richard Boyd (1989, 1991, 1999a, 1999b, 2010) developed an alternative theory of natural kinds. Boyd's approach does not require traditional essences that are microstructural, intrinsic, ahistorical, immutable or defined by necessary and sufficient conditions. Instead of traditional (modal) essences, Boyd's view ascribes homeostatic property clusters to natural kinds. A homeostatic property cluster is a grouping of properties that features a causal mechanism that allows for stability among properties in the grouping. This mechanism ensures that deviations in the cluster persist only seldomly. When we determine a kind member *K*, we can infer that *K*

possesses other properties besides those that make it a kind member. The occurrence of some properties in the cluster makes it more likely that others will correlate. Thus, the mechanism is *homeostatic* in the sense that it maintains a stable range of properties. Without the key feature of the homeostatic mechanism, scientific explanations and predictions would lack power and licence (Griffiths 1996). Thus, for HPC kind theorists the view enables kinds to have explanatory and predictive success—or *explanatory integrity* (Wilson et. al 2007). Boyd and other HPC kind theorists[10] apply HPC kind theory to biological phenomena and explain that species and other biological entities are paradigmatic candidates for HPC kinds. For Wilson (1996, 1999) and Wilson et. al (2007), biological natural kinds are best understood as HPC kinds because HPC kind theory makes better sense of the ways the biological sciences engage in explanatory and inductive practices.

Boyd's HPC account embraces various features of natural kinds including variability, vagueness, pluralism, and historical and extrinsic relational properties, which are not characteristic of traditional natural kinds. HPC kinds fail to satisfy necessary and sufficient conditions for kind membership. In this sense, HPC kinds do not have sharp boundaries. HPC kinds do not have necessary and sufficient conditions or specify any necessary properties (modal, microstructural, intrinsic or otherwise), like traditional natural kinds, what makes a member belong to a kind is an *a posteriori* matter. That is, which homeostatic mechanisms count (and to what extent) in determining membership can only be resolved empirically. Furthermore, HPC kinds are *variable* in the sense that HPC kinds have "natural flexibility and explanatory integrity" (Wilson et al. 2007). For Wilson et al., the hallmark feature of HPC kinds is that they are "intrinsically heterogenous," which renders HPC kinds flexible.

[10] Such as Paul E. Griffiths (1996), Robert A. Wilson (1996, 1999), and Robert A. Wilson, et al. 2007).

HPC kinds have *vague* boundaries. And since they lack necessary and sufficient conditions *and* their properties can vary across time and space, the flexible extension of HPC kinds precisely accommodates the classificatory schemes that are relevant to causal phenomena. For example, in the species case, Boyd points out that: "It follows from evolutionary theory that [a species] will ordinarily lack completely determinate boundaries," thus any attempt to pinpoint the definition of a species precisely would misrepresent "biological reality" (Boyd 2010). What's more, not only can variability account for the vague boundaries of HPC kinds, the view's core feature of intrinsic heterogeneity can better accommodate some forms of *pluralism* about natural kinds by enabling integration.

Rather than separating phenomena into more fine-grained distinct kinds, theoretically interesting similarities amongst phenomena can be integrated into a single broader kind on the HPC approach (Wilson et al. 2007). For example, there are deserts that lack necessary properties in common. The Sonoran desert is midlatitude, lacks precipitation, has intensely hot summers, and has a relatively low elevation. The Chihuahuan desert is also midlatitude and has very hot summers but relatively high elevation, while others are trade wind deserts with variable daily temperatures (e.g., the Sahara) or are high latitude deserts that are extremely cold and perpetually covered in snow and ice (the Arctic and Antarctic Polar deserts). Amongst other properties, these deserts vary in terms of elevation, flora and fauna, temperature range, and a capacity to support human life. These deserts lack necessary properties in common, but the ability to integrate these phenomena into a single kind *desert* can contribute to scientific explanation and prediction in ways that a traditional kinds approach cannot. The reason for this is that the flexible extension of

HPC kinds is able to include deserts' diverse features while accounting for their varying causes of dryness.[11]

In addition to variability, vagueness and pluralism, HPC kinds feature extrinsic relational and historical properties. In order to flesh out what an extrinsic relational property is it is useful to highlight the common intrinsic vs relational property distinction in the metaphysical literature. Famously, David Lewis (1983) drew a distinction between intrinsic and extrinsic properties when he argued that intrinsic properties are those which objects have in virtue of the way objects are, e.g., having brown eyes is an intrinsic property of an individual. He contrasted this notion of an intrinsic property with an extrinsic property which objects have in virtue of their relations or lack of relations to other things. For example, having a sibling with brown eyes is not an intrinsic property, but is an extrinsic relational property. This is a common and intuitive understanding of intrinsic vs. relational properties, but it is worth noting that relational properties can also be intrinsic such as the two-place relation of an identical twin sibling being composed of the same human DNA as their twin. Because relational properties can also be intrinsic, I specify that HPC kinds include *extrinsic* relational properties. It is beyond the scope of this chapter to unpack the differences between intrinsic vs. extrinsic properties or intrinsic relations and extrinsic ones further.

Applying this discussion to HPC kinds, although the chemical kind gold has as its essential (and intrinsic) feature the microstructure Au79, biological kinds such as taxa have important extrinsic relational properties. A biological kind is a grouping of biological organisms that have some properties in common that enable robust generalizations. Like traditional natural kinds, biological kinds also permit inductive inferences and feature in causal explanations.

[11] It is worth noting that deserts are dry, which arguably is what is to be a desert.

In the case of the higher taxon *Homo*, species belonging to this taxon share some but not all phenotypic and genotypic properties in common. The fact that *Homo sapiens* and *Homo erectus* share features in common is explained by common ancestry from a founding species such that common ancestry is the homeostatic mechanism that determines the identity and boundary of the higher taxon *Homo.* Common ancestry is an extrinsic relational property, i.e., being descended from a founding species is property of a species. A species has this property due to its relation of descendance from the founding species. Not only is common ancestry a relational property, but it is also a historical property as it specifies a relation of historical descent. Other relational properties that serve as homeostatic mechanisms for species are interbreeding, ecological selection and gene flow.

Extrinsic relational properties play a key role in explaining how HPC kinds are able to maintain their integrity despite kind members' having variable intrinsic properties. Colouration is another example. Wilson et al., note that dark moths' colouring is a relational property:

> A dark moth's property of being fitter than peppered moths is a relational property, one realized in part by the colours of other moths and by the selective pressure (say, soot-darkened habitat) with respect to which it makes sense to talk of fitness. The reliable instantiation of this relational property among dark moths—and thus the environmental context that in part realizes those instances—helps explain why those moths form a natural kind, a group of moths whose members are being selected for, despite variation among those moths' dark colourations and other intrinsic properties (2007, 20).

What the moth example highlights is that extrinsic relational properties that are "reliably instantiated" help explain how the homeostatic mechanisms can feature variation but be stable enough to individuate natural kinds. For HPC theorists, species are HPC kinds because they yield predictions and explanations in biology, which depend on imperfectly shared but stable morphological, physiological and behavioural properties. Wilson et al., contend that "surface" features of a species (morphological, physiological, developmental and behavioural) are

indicative of particular species clusters due to causally "basic" features such as common ancestry, interbreeding and gene flow that support species cohesion.

Within the HPC kind literature, biological kinds are treated as exemplary HPC kinds due to their inherent flexibility. Boyd (1991), however, also maintains that social kinds can be rightly subsumed under HPC natural kinds. Social kinds are groupings of social objects or phenomena that in at least some cases permit inductive inference and explanation. For Boyd, any property cluster kind or social kind that is central to induction or explanation will be determined *a posteriori*, will be determined by the causal structure of the world (rather than human convention), and will depend on the existence of epistemically relevant patterns of causal relations between instances of a kind and the use of a kind term rather than by linguistic convention. Boyd does not offer a full-fledged positive account of how HPC natural kinds cover social kinds, but there are other kinds theorists who take a realist approach to social kinds who do offer a more robust account of social kinds as natural kinds. Muhammad Ali Khalidi is one theorist who takes a realist approach to social kinds and views at least some social kinds as natural kinds.

2.3. Khalidi's Kinds: A Simple Causal Theory

Khalidi (2013) is sympathetic to the main motivation of Boyd's project to provide a realist account of natural kinds that has a scientific focus while also decoupling natural kinds from modal essences. Khalidi criticizes Boyd's account of HPC kinds as too restrictive and offers his own account by drawing on Carl Craver's (2009) 'simple causal theory' of natural kinds. Khalidi argues that Boyd's account of HPC kinds is too restrictive because it assumes a 'one-size fits all' single causal template that works for all instances of natural kinds. Instead, he questions whether a homeostatic mechanism is even required for something to be a natural kind.

Khalidi contends that there are some biological kinds for which a homeostatic mechanism appears to be important while there are other biological kinds that may not have a single causal mechanism. The key difference between Khalidi and Boyd's views is that while Boyd advocates for a single well-defined causal mechanism that achieves the stability of a property cluster, Khalidi's account favours a network of causal relations between properties. Khalidi's simple causal theory focuses on causes between properties. On his account, stability can be achieved through a complex network of causes, including chains of reliably reoccurring causal properties. He illustrates how stability can be attained with a reliably reoccurring causal chain by using the example of larvae.

Khalidi offers larvae as an instance of a biological kind that do not appear to have a single causal mechanism. Rather, they seem to have a set of reliably reoccurring properties insofar as it appears that properties at one stage of development give rise to properties at another stage of development, e.g., a larva's ability to procure food partly causes the development of the mature imago. In turn the imago's reproductive success facilitates the next generation's larvae, which will have traits geared towards finding food sources (Khalidi 2013). The point of this example is to show that it appears that the larva's adeptness at finding food is a reliably reoccurring causal property and does not emerge from a single causal mechanism.

Boyd and other HPC kind advocates hold species as the paradigm case for an HPC kind, Khalidi calls this idea into question. He argues that assuming that there is a homeostatic mechanism in each species that (typically) holds its properties in equilibrium is contrary to contemporary understandings in biology, which reject "normal state" typological thinking about species. Instead, contemporary understandings in biology maintain that variability (rather than divergence) among species is the norm. Here, variability, rather than divergence from a stable

state, is the norm because species' properties change through mutation and natural selection—sometimes to the extent that a speciation event occurs and a new kind emerges. What happens more often is that a species continues despite substantial divergence from its ancestral form. Khalidi rejects the idea that property cluster kinds have a single well-defined causal mechanism. Since he sees a variety of causal properties as giving rise to biological kinds, Khalidi does not view HPC theory as being able to adequately account for the causal properties of species and other biological kinds. As an alternative, he contends that there are networks of causal properties which are situated in a hierarchy of causal priority that can depend, in intricate ways, on context.

2.4 What is a Simple Causal Theory?

Both Khalidi (2013, 2015, 2021) and Matthew Slater (2009, 2013, 2015)[12] advocate for a simplified approach to natural kinds in the vein of Craver's (2009) account. As highlighted above, the purported advantages of a simple causal theory over the HPC view are the absence of a required homeostatic mechanism, which in turn would enable a theory of natural kinds to better capture the range of causal properties and processes responsible for the existence of a kind. And the second advantage is that a simple causal theory fits better with contemporary biology, which holds variability as the hallmark of biological phenomena. Craver (2009) argues that it is possible and preferable to endorse many of the characteristics of the HPC account (e.g., variability, extrinsic relational properties, vagueness) but reject the core feature of the homeostatic mechanism. He explains that for the simple causal theory natural kinds are "the kinds appearing in generalizations that correctly describe the causal structure of the world regardless of whether a mechanism explains the clustering of properties definitive of the kind"

[12] Slater refers to his view as stable property cluster (SPC) kinds.

(Craver 2009, 579). Thus, without a (necessary) centralized causal mechanism, the simple causal theory is thought to capture more diverse and varied causal relations of natural kinds.

Both Khalidi and Slater advocate for a simplified approach, Khalidi's view centres on the causal relations between properties that account for stability, whereas Slater's SPC account focuses on the presence of certain property clusters invoking stability, rather than on *how* that stability is achieved. Khalidi's account is principally causal, but Slater's is not. First, I shall delve further into what is distinctive about Khalidi's account, then turn to Slater's. Khalidi (2013) argues that there is a causal link between properties associated with a kind where one or a few properties are causally prior. When one or a few properties are the primary properties of the kind, there are a range of other properties that are linked with that kind and are causally related. Khalidi distinguishes between the primary and secondary properties of a natural kind. The primary properties are co-instantiated while the secondary properties have instantiations that follow. He contends that in most circumstances, although the primary properties linked to a natural kind have causal priority, they do not necessarily *determine* the other properties linked to the kind. The reason for this is that the causal relationships between primary and secondary properties are probabilistic. More than property clusters, or even weighted property clusters with some clusters factoring into the structure of a natural kind more significantly than others, Khalidi argues that natural kinds are best understood as *nodes* in causal networks. These nodes stand to individuate natural kinds, and according to Khalidi, the causal structure of each kind is what distinguishes them in particular.

Like Boyd's, Khalidi's account focuses on the kinds discoverable through studying the special sciences. What distinguishes those kinds discoverable through scientific investigation from other (non-natural) kinds is their network of causal properties. The causal relations among

the properties in the network secure that natural kinds permit inductive inferences and have explanatory value. For Khalidi, only natural kinds are discoverable by the sciences. Moreover, he maintains that natural kinds are individuated by their causal relations because these types of relations are *real* features of the world. He contends, "If science is the enterprise devoted to gaining knowledge of the universe, and if science is primarily engaged in discovering causal relationships, then this should lead us to think that causal relations are privileged features of reality" (2013, 209). In addition to the role that scientific investigation plays in the study of natural kinds, Khalidi also draws on the fairly uncontroversial connection between *being real* and having *causal powers*. That is, from Plato to Samuel Alexander (1920) and Jaegwon Kim (1998) it is commonly held that having causal powers is a condition of being real.[13] We can identify Khalidi's version of the simple causal theory as a naturalistic one that is concerned with the kinds studied and (ideally) captured by the special sciences. In this sense, he is a scientific naturalist. In Section 4, I shall revisit the issue of whether naturalness necessarily accompanies having causal powers. I'll look at whether a kind can influence causal interactions or causal processes, and thus be real, while also being non-natural.

On the one hand, Khalidi (2013) offers a simple causal theory where natural kinds are nodes in networks of causal relations, while on the other hand Slater's (2009) view is not principally causal, but rather the simplicity of his view focuses on the stable clustering of properties. Slater (2009) offers his stable property cluster account as an alternative to the putative shortcomings of the HPC approach. On his view, the requirement that homeostatic mechanisms individuate natural kinds should be abandoned in favour of plain stability, which may or may not involve a mechanism. He argues that his SPC theory sheds the unclarity of what counts as a

[13] My discussion of causal powers is meant to suggest that causal powers are one condition for being real, which leaves open that there may be entities that lack causal powers but are real.

single mechanism for a particular kind, and instead focuses on the stability of a kind, rather than on how that stability is created. On Slater's account, some properties clump together in a "systematically sociable" fashion either because when one property is instantiated others are also instantiated *or* there is a robust tendency for certain properties to show up together in a "cliquish" fashion (2009, 177). He uses cells to illustrate the stability of property cluster kinds, but also to show how stability can come apart in different contexts. Slater contends that cells are associated with characteristic clusters of properties. His view ties natural kinds to scientific practice where different investigative contexts can reveal the characteristics of natural kinds. Slater maintains that biologists acknowledge and utilize clustering types in a variety of contexts. He holds that we can find stability through observing the relevant property clustering across different contexts (e.g., among distinct organisms and species).

On Slater's view, biologists can infer that something is a natural kind based on observing the degree to which properties cluster, are stable, and under what conditions their stability adheres. He uses the example of glial cells, which are cells that aid and buffer neurons. The properties of aiding and buffering neurons are dispositional properties. Slater argues that when a glial cell is taken out of its organism (e.g., for the purposes of culturing or freezing in the lab), we can expect that the functional properties of aiding and buffering (and other dispositional properties) associated the cell will fall away. Many of the structural properties of the cell will, however, stay the same. Thus, for Slater, the property cluster that includes dispositional and structural properties has changed in a different investigative context. The dispositional properties of the glial cell become unstable outside of its organismal context, it is possible that we might rightly refer to the glial cell in its extra-organismal context as a natural kind. The reason being is that when this cell is in its organismal context, its property cluster *is* stable and thus useful for

induction and explanation. Furthermore, even when its property cluster is not stable it still has the history of functioning as it would in its organismal context, and can be used for making sense of cells of the same kind in a different context. On his account, SPC kinds do not permit sweeping inductive inferences insensitive to context, but rather enable inferences in light of certain circumstances and background knowledge. For Slater, the clustering of properties and our ability to make inferences about a kind's (e.g., biological) role is what is important for what it is to be a natural kind.

2.5 Social Kinds as Natural Kinds

Both Khalidi and Slater offer versions of the simple causal theory that reject the notion of a necessary homeostatic mechanism. Khalidi's account rejects a mechanism in favour of a causal account of nodes in complex networks, whereas, Slater eschews the mechanism central to HPC kinds for the purposes of centralizing the roles of clustering and stability (under different conditions) in his notion of SPC kinds. What Khalidi's simple causal theory, Slater's SPC kind theory, and HPC kind theory have in common is a focus on the flexibility and extrinsic relationality of natural kinds. They all provide realist alternatives to traditional natural kinds that emphasize the need for our scientific theories to be altered in light of what natural kinds there are in the world. In this sense, the central domain of these alternative approaches is the phenomena amenable to scientific investigation. Both Boyd and Khalidi include social phenomena in this domain and argue that (at least some) social kinds are natural kinds insofar as the former have *causal relations* as a central feature. As mentioned, for Boyd, social kinds are candidates for natural kinds if they allow inductive inferences or play a role in explanation. The existence of such social kinds will be determined by the causal structure of reality and will depend on the existence of epistemically pertinent causal relations between kind instances and kind terms. Even

though Boyd only offers a sketch of what a theory of social kinds as natural kinds might look like, Khalidi provides a more robust account on his simple causal theory.

Khalidi (2015) rejects the common idea that mind-independence is (part of) what makes a natural kind *natural*. The reason for this is that he views mind-independence as a misleading and irrelevant criterion for natural kinds. As a consequence, he considers natural kinds to include those kinds that are mind-dependent (where the existence of a kind is dependent on human minds). Thus, those kinds whose existence depend on human minds can be natural kinds, which includes social kinds. Khalidi delineates three types of social kinds which he points out are all mind-dependent. The first is a *social kind* that has an existence that *does not depend* on human beings having any beliefs or other propositional attitudes *towards it* (for instance, racism). What is unique about the first type of social kind is that it exists in the world even if there are no particular attitudes with respect to it. For example, racism exists in the United States even if there are people who are ignorant to it or blatantly deny it. Thus, a social kind of this first type is real even if no one has a belief or attitude towards it, i.e., Jim Crow laws would be racist even if no one believed that they were. This type of social kind is mind-dependent in the sense that its existence relies on human norms, activities, and behaviour, but does not require any propositional attitudes about racism. The second type of social kind is one that has an existence that *depends* in part on specific attitudes that human beings have *towards it* (but not necessarily towards its particular instances) (e.g., currency). Social kinds of the second type exist even if humans fail to recognize some instances of the kind. For example, although currency only exists to the extent in which people treat various instances as currency, it is still real if some instances go unrecognized. A Canadian loonie that finds itself abroad still exists as currency in Canada

(and at a currency exchange) even if it is not recognized or treated as currency in an outside country.

The third type of social kind (and that of its particular instances) has an existence that depends in part on specific attitudes that human beings have *towards it* (e.g., permanent resident). What is different about this third type of social kind is that its consists solely of social-legal conventions and does not feature discoverable causal relations. For instance, in the case of permanent resident, the status of *permanent resident* (and that of its instances) depends only on human attitudes towards what counts as a permanent resident at a time and place (in a certain time period of legal norms in a country). The kinds racism and currency also have social and legal features, those kinds do not solely depend on social-legal conventions, but instead also depend on causal relations and factor into causal explanations. For example, racism features into a causal explanation of food deserts in the United States even though race-based discrimination violates federal law in the country. Further, no one has to believe that food deserts are racist in order for them to be so. In the case of currency, independent of social-legal conventions around currency (e.g., depositing it in a bank, not banking offshore) it can still have impacts on the world (e.g., making some wealthier) even when conventions are flouted and others are unaware of its existence.

On Khalidi's view, the mind-dependence of these kinds does not make them ontologically subjective or conventional. He considers all three types of social kind to be mind-dependent, but he views the first and second type to be *real* to the extent they have discoverable causal relations. Khalidi treats the third type as a non-natural kind insofar as it is not *real* but is wholly dependent on social-legal conventions. Social and legal conventions can be explanatory, but they do not offer causal explanations since they do not feature causal relations that can be

discovered through investigation. In other words, the third type of social kind is a conventional kind because its existence depends on the perceptions and attitudes of humans, but the first and second types of social kinds are *natural* kinds because their properties are causal. Given Khalidi's scientific naturalism, kinds that are real are capable of making a causal difference in the world and are amenable to scientific investigation; thus, such kinds count as natural kinds on his view. Those social kinds that are not discoverable through scientific investigation are conventional and non-natural. Khalidi's account contrasts with other prominent accounts in the social kinds literature, viz., those of Sally Haslanger (2000, 2012) and Ian Hacking (1999), who generally deem social kinds to be real but a distinct category from natural kinds. I shall delve further into the formulation and challenges of Khalidi's account of social kinds in Section 3.

3. Social Construction and Social Kinds

As stated above, social kinds are groupings of socially constructed objects or phenomena that in at least some cases enable inductive inference and explanation. Those social kinds that have inductive and explanatory value have this value in virtue of their causal roles in the world. Boyd and Khalidi view any kind that has a causal influence on the world to be real, and therefore, natural, others view social kinds as real, but social. For Hacking (1999), *causal* relations are key for the construction of social kinds. For Haslanger (2003, 2005, 2012), on the other hand, the realness of the social rests on causal relations, but also, importantly, on *constitutive* relations. Before I delve deeper into the differences between causal and constitutive relations and how they are important to the ontology of social kinds, it is useful to examine social construction in order to see *how* social kinds acquire their causal and constitutive properties and relations.

3.1 Social Construction

There are many theories of social construction. For my purposes, I'll focus on kind constructionist theories. Constructionist theories of social kinds assert that kind features can be explained by cultural practices and attitudes rather than natural processes that function relatively independent of culture (Mallon 2019). Socially constructed phenomena are usually contrasted with natural phenomena that are determined by the laws of nature or the structure of the natural world. We might contrast a Himalayan crystal salt lamp with halite as two different kinds of thing—the first being created by capitalist interests and the second developed by geological processes. Social construction is often pitted against biological realism (the view that a particular category is a real biological natural kind) and anti- realism (the view that a particular category refers to nothing that is real—the category is empty), while social construction is a realist view of the nature of a particular category, i.e., it is a real feature of the world, but is determined by social, instead of natural or biological properties.

There are a plethora of social constructionist claims stemming from work in sociology in the 1960s[14] to contemporary work in sociology, philosophy, and critical theory. Social constructionist claims can also range in method, motivation and robustness. I draw distinctions between strong, moderate, and weak social constructionism[15]. Strong social constructionist claims might assert that a large part of reality is created by human conventions.[16] Another way to

[14] In 1966, sociologists Peter Berger and Thomas Luckmann published *The Social Construction of Reality*, which served as a foundational work in social constructionist theory.

[15] It is worth noting that, similar to Hacking, I use the term 'social construction' rather than 'social constructivism.' Within the humanities and social sciences, I take it that there is no crucial difference between the two terms. I merely favour 'social construction' because it carries the connotation of (agents engaged in) 'building' or 'developing.'

[16] By human conventions, I mean practices like following traffic norms, which exist based on behavioural regularities that are contingent upon on the ways that everyone behaves (Mallon 2007; Lewis 1969). People follow traffic norms because everyone else follows them. A convention requires common knowledge and common participation.

think about strong social constructionist claims is that they take much of reality to be mind-dependent, i.e., dependent on human thinkers/perceivers. Moderate accounts, on the other hand, maintain that the existence of some parts of reality are owed to non-conventional facts, while other aspects of reality are owed to human convention. For example, a moderate social constructionist might hold that there are aspects of human cognition that constrain human behaviour, but this does not mean that certain types of human behaviour are necessary, or that these behaviours will inevitably lead to certain types of social practices.

For purposes of the example, let's say that humans have a robust psychological tendency towards nepotism, which leads people to engage in nepotistic practices in social institutions. For the moderate social constructionist, having a psychological tendency towards nepotism does not mean that acting on that tendency is necessary. Thus, nepotistic practices in social institutions are not inevitable. Instead, there are ways that the social world can mitigate that tendency, (viz., prohibiting nepotism in hiring practices), perhaps even to the point where it is only rarely instantiated. The moderate social constructionist acknowledges that the nepotism tendency is at least partly rooted in non-social factors, but they also hold that such a tendency can be managed through social intervention, (viz., through adopting fair hiring practices that are based on qualifications, rather than familial relations). Finally, for weak social constructionism only objects like campy films, money, or traffic lights are socially constructed insofar as humans created them and tacitly agree to act as though they exist (Pinker 2002). For the weak social constructionist, much of reality might be mind-independent and only a relatively limited part of reality is socially constructed.[17] In line with Hacking (1999), it seems that what these different

[17] In addition to thinking about social constructionist accounts as *strong*, *moderate* or *weak*, Ron Mallon et al. (2009) draws a distinction between *global* and *local* social constructionist accounts. On the global view, every fact is a social construction (which could be understood as a *very strong* social constructionist approach), and on the local

types of social constructionism hold in common is that they assert that for something *X* to be socially constructed means that *X* is not determined by the natural world and *X* is not inevitable.

Ron Mallon (2007) goes beyond this idea by noting that for social constructionists what makes *X* socially constructed is that it is contingent upon human culture and decisions, which in turn depend on various "theories, texts, conventions, practices, and conceptual schemes of particular individuals and groups of people in particular places and times" (94). What is more, some social constructionists are interested in engaging in descriptive projects, that is, in unpacking how human cultures and decisions socially construct *X* or *Y*. Others are also interested in understanding how particular things are socially constructed in order to map out alternative ways those things could be. Such social constructionists usually have social or political aims in mind.[18] Both Mallon (2009) and Haslanger (2012) offer influential insights into how social construction can operate covertly. What Mallon (2009) labels *covert* construction is of particular interest to those social constructionists concerned with social-political aims. Mallon (2009) contrasts covert construction with *overt* construction. Things that are overtly socially constructed are objects like money and traffic lights, and such constructions are uncontroversial. Things that are covertly constructed are presumed natural but are actually social. Rather than by natural causes or constitutions, covert social constructions are socially caused or constituted. Gender is an example of a covert social construction. The social positions of women and men were once widely assumed to be based in anatomical and other biological differences. There are still individuals who believe that the social roles of women and men are natural and determined by

view, only particular facts are social constructions. Local social construction is compatible with both moderate and weak versions of social construction.

[18] See Sally Haslanger's (2000, 2012) body of work on ameliorative projects for gender and race, Kate Manne's (2017) ameliorative account of misogyny, and Ingo Brigandt and Esther Rosario's (2020) strategic conceptual engineering approach to concepts of gender and race.

biology, and as I'll discuss in Chapter VI, this view is still present in case law related to sex assignment, it is no longer held as broadly as in previous decades. In this way, that gender is a social construct is 'controversial' because it is covert—it is not necessarily obvious that gender is social and requires an analysis of its mechanisms and component features.

3.2 Social Kinds

I suggested above that recognizing that a kind is socially constructed makes an important ontological and explanatory difference as philosophers are parsing out what kinds there are in the world and what sort of impacts they have. What does social construction have to do with social kinds exactly? The sort of social constructionist view one endorses, whether it is of a strong, moderate, or weak variety will affect how one views the social ontological landscape, i.e., what sorts of social kinds putatively exist, and what causes or constitutes their existence. As I mentioned above, Hacking (1999) and Haslanger (2003, 2005, 2012a) offer key conceptions of how social kinds are constructed. Like Khalidi's, their accounts both fall under moderate social constructionism, but Hacking's and Haslanger's accounts have important differences. The two central differences between their accounts is that, first, Hacking provides a descriptive analysis of a particular type of social kind, what he calls *interactive kinds*. Haslanger, on the other hand, engages in an ameliorative (normative) analysis of social kinds. The second difference is that Hacking offers a causal account of the construction of (particular) social kinds, whereas, Haslanger's account centres on the constitutive relations of social kinds.

4. Hacking's Interactive Kinds

First, let's consider Hacking's view. Hacking offers an account of *how* specific social kinds—interactive kinds—are socially constructed. In order to develop his notion of interactive kinds, he distinguishes between three different types of social construction: object construction,

idea construction, and what he calls "elevator words" (1999, 21). Objects that are socially constructed (and understood in a common sense way to be part of the world) include people (women), states (womanhood), conditions (health, disordered eating), practices (police violence, doing yoga), actions (swimming, murder), behaviour (magnanimous, fidgety), classes (upper), experiences (of falling in love, of losing a child), relations (gender), material objects (rocks), substances (sulphur, quartz), unobservables (genes, sulphate ions), and fundamental particles (quarks). These examples are object constructions.

For Hacking, those things that are idea constructed are concepts, beliefs, attitudes to, and theories. Ideas are the types of things that are discussed, shared, stated, sorted out, clarified, and contested—principally by objects (humans). Ideas may be illustrative, opaque, useless, or clear and distinct. On his account, kinds, classifications, and groupings are ideas, and their extensions are objects. For example, the kind *child migrant* would have as part of its extension the group of migrant children at the El Paso Service Processing Center on the US/Mexico border. For the third type of construction, what Hacking calls 'elevator words' are words such as 'facts' and 'truths.' Such words are used to state something about the world, or about our attitudes and beliefs about the world. For Hacking, facts and truths are not in the world in the same way that objects like chairs or the experience of falling in love are. Examples of fact and truth construction would be the claim that scientific communities construct 'scientific facts,' groups of scientists, industry interests, and policymakers construct 'health facts,' that intelligence communities construct 'intel,' or that politicians and media outlets construct 'truths' or even 'post-truths.' The construction of 'elevator words,' like facts, is different from the construction of objects or ideas because facts and truths are propositional rather than causal. Elevator words feature into a different kind of explanation (i.e., propositional) rather than causal explanation as

object and idea construction do. I should note that the distinctions between Hacking's three types of construction are not sharp distinctions.

Object and idea construction are important to Hacking's notion of interactive kinds, and I'll focus on these types of construction for my own purposes—they are particularly interesting due to their causal roles. In what follows, I'll also focus on object and idea construction so that I can better investigate how these types of social construction fit into the development and maintenance of social kinds. Hacking (1999) claims that constructionism calls into question what we take for granted as inevitable and real. As I aim to show, however, a more advantageous understanding of social constructionism calls into question what we take as natural and exposes it as social. Social causes play a key role in the construction of social phenomena. The better we understand the construction of social kinds, the better we can represent them with appropriate concepts, and the better we can make sense of social groups, kinds of person and certain aspects of human behaviour.

In order to further unpack the ways in which social kinds can be socially constructed, let's delve deeper into Hacking's object and idea construction. Hacking (1999) proposes that some objects and ideas causally interact in the world. These causal interactions give rise to Hacking's notion of *interactive kinds*. He uses Multiple Personality Disorder (now referred to as Dissociative Identity Disorder [DID]) as an example of an interactive kind.[19] Hacking thinks there is a causal feedback loop that exists between *the person* with MPD and exposure to *ideas about persons* with MPD. Thus, ideas about MPD, e.g., exposure to fictional characterizations of patients with MPD presenting animal personalities, altered the conditions of those with MPD

[19] Many of Hacking's (1999) examples of interactive kinds are psychiatric kinds including bipolar disorder and attention deficit disorders (ADD and ADHD).

causing a higher occurrence of actual individuals with animal personalities where none had previously manifested (Hacking 1986, 1995, 1999; Cooper 2004).

To illustrate this type of causal interaction further, I'll introduce my own example of *some individual women* and the *idea of White womanhood in the United States*. Here we have an object (some individual persons who identity as women) and an idea (the concept of White womanhood). When these two social constructions interact, they can produce other social constructions, viz., the state of White womanhood for an individual, and certain types of behaviour in an individual. Individual White women in the US can be aware of what White womanhood means in that cultural context, which can influence behaviour in social situations where race is made salient, e.g., in situations of perceived dispute with another person or persons of a different race. At least since the Antebellum, the concept of White womanhood in the United States has centred around the notion that White women should be protected from BIPOC persons, particularly from Black and Indigenous men. A central way that an object and an idea interact in this case is that the person (some individual White woman) can be aware of herself as a White woman (her state of White womanhood) and the social privilege that that status carries. As a result, she may go on to behave in harmful ways, e.g., in a perceived dispute with a Black or Indigenous person her awareness of her White womanhood may lead her to call the police.

White womanhood, however, can also be leveraged for social goods, and an individual woman's awareness of her state of White privilege can be used in some kinds of social justice advocacy. In other contexts, a White woman's awareness of her status may have little or no social effects[20], but the point is that self-awareness can serve an important causal function in the

[20] I imagine that being a White woman aware of her White womanhood on a desert island might have little or no social effects. The fatal shooting of Breonna Taylor on March 13, 2020 while she was sleeping in her apartment seems to show, however, that even the most private and ordinary activities can have racialized social effects.

social world. The way that an object and concept interact in the example above requires an agent with self-awareness. A material object like a quartz stone would not feature into an account of causal interactions in this sense. As Hacking explains it, ways of classifying humans interact with those who are so classified. In the case of the example above, the idea of White womanhood interacts with the individual to form an interactive kind. Not only is the classification White woman a social kind, it was also a legal classification in the US. This classification has a socio-legal and institutional history, which appears to still carry traction in the contemporary US.[21]

Another example of how such causal interactions between objects and ideas occur is the case of stereotype threat in women and girls in some educational settings. Stereotype threat is the psycho-social phenomenon where the awareness of one's membership in a targeted social group negatively impacts one's performance. For instance, in the West, women and girls tend to be stereotyped as having inferior mathematical ability. Research from social psychology shows that women and girls who experience stereotype threat underperform on tasks such as a mathematics test because they have unconscious anxiety over affirming stereotypes about their social group (Nosek et al. 2009). Stereotype threat is usually triggered when the target's gender is primed, e.g., having to indicate one's gender before taking a math exam. Some can be so anxious about affirming gender stereotypes (e.g., about women and math) that their heart rate and blood pressure increase, thus stereotype threat has not only psycho-social elements, but physical

[21] The 2020 Memorial Day weekend incident in Central Park that involved a White woman calling the police on a Black man who asked her to leash her dog seems to support the notion that self-awareness of White womanhood interacts with the individual. On the 911 call, the woman claims that an "African American man" threatened her and her dog, though the video footage that the man recorded does not support this claim. The White woman in this case appears to weaponize her White privilege; one can only do so if they are self-aware. Nir, Sarah M. "White Woman is Fired after Calling Police on Black Man in Central Park." New York Times Online. The New York Times, 26 March 2020. https://www.nytimes.com/2020/05/26/nyregion/amy-cooper-dog-central-park

aspects as well (Saul 2012). Again, for Hacking (1995, 1999) self-awareness is key in establishing an interactive kind. The negative stereotype about women's inferior mathematical ability interacts with the woman (or girl) and causes a change in behaviour (e.g., on performance and working memory) that otherwise would not have happened if the testing environment were gender neutral (Fine 2010). In addition to the above example of White woman and White womanhood, stereotype threat also seems to fulfill the criteria for Hacking's notion of an interactive kind.

What do the causal interactions that feature chiefly into interactive kinds look like on Hacking's account? They take the form of "looping effects" (Hacking 1995, 1999). Objects such as states like White womanhood and professorship are developed around kinds of people such as White women and professors. Individuals who belong to these kinds can make tacit or overt choices, alter how they live or present themselves so as to better adhere to or to disavow the state they are classified under. Hacking highlights that such choices and alterations have consequences for the kind of people in question. I would add that depending on the kind and choices made there may be consequences for other groups (kinds of people) as well. These choices and alternations that stem from the self-awareness of one's classifications are causal interactions that can result in the alteration of the kind itself. In this way, looping effects are central in the construction of interactive kinds.

Let's take another example in order to highlight how looping effects function in interactive kinds. Consider the Health at Every Size (HAES) movement, which aims to destigmatize being overweight or obese as necessarily indicators of poor health. In addition to the associations of the classifications *overweight* and *obese* with certain health statuses, e.g., type 2 diabetes, coronary artery disease, hypertension, several cancers, stroke, osteoarthritis, and sleep

apnea (among other conditions), the stigma of being overweight or obese also carries a negative moral valuation (Penney and Kirk 2015; Welsh 2018). Such stigma includes being considered lazy, irresponsible, lacking 'will power' and good decision-making. In light of these moralizing stereotypes, rather than encouraging fat people to simply lose weight, HAES advocates for viewing health in a holistic fashion, instead of in terms of single markers like weight, Body Mass Index (BMI), or body size as proxies for health. HAES promotes the idea that health exists on a continuum that varies with time and the circumstances of an individual's life. They also reject the notion that an individual's weight is a choice and that weight and body size are properties that are morally praiseworthy or blameworthy. Instead, HAES maintains that promoting health involves developing sustainable practices that support the well-being of individuals and communities, which requires public policy implementations that make health resources safe, affordable, and accessible. HAES upholds that health is possible for people of many sizes and that a preoccupation with weight can negatively affects one's health. Some sustainable practices they promote include foregoing weight-loss dieting in favour of eating for well-being, engaging in pleasurable forms of exercise and movement, and respecting body diversity. HAES is an example of a looping effect because the movement starts with awareness by a group of people. The group is aware of the classification that being overweight or obese is 'necessarily unhealthy,' then the group works to change the classification from fat people *cannot* be healthy to fat people *can* be healthy. In short, a change in behaviour amongst the group that is so classified can loop back and change the classification and what is known about it. So, on Hacking's view what was once known about people of a kind may come to no longer apply because individuals of that kind can change (and thus change their kind) in virtue of what they believe about themselves.

5. Contrasting Hacking's Interactive Kinds with Haslanger's Ameliorative Analysis

At this point, it is important to situate Haslanger's views on the social construction of social kinds with Hacking's since their accounts of social construction are central in the social ontology literature. Haslanger (2000) argues famously that the goal of feminism is to bring about the day when there are "no more women." If we understand this aim in light of Hacking's interactive kinds, we can see that a claim like this does not advocate for the elimination of individual women. In fact, Haslanger advocates for an elimination of the classification *woman* and all of its connotations, which on her analysis means a social position that is systematically subordinated along various dimensions to *man*. For Haslanger, changing the concepts WOMAN and MAN can lead to more socially just ways of classifying people, and as a consequence lives that are less oppressed.

Haslanger's (2000) constructionist account takes up the work of analysing certain categories like *race*, *woman* and *man* that appear to be natural or biological, but upon further investigation are discovered to be social. Hacking's interest in the ways idea construction impact object construction are not too far off from Haslanger's work on categories. She is interested in revealing how phenomena that humans take for granted as natural, e.g., the constructions of race and gender, are actually social constructions that are alterable. Importantly on her account, such constructions are alterable for ameliorative (social justice) purposes. In this sense, Haslanger offers an ameliorative analysis of certain social kinds.

Hacking's (1999) work with social construction, on the other hand, has less of an ameliorative focus and is more concerned with shedding light on the mechanisms that give rise to socially constructed kinds of people and how ideas and (groups of) persons interact to change those constructions. Specifically, Hacking is concerned with how the mechanics of looping

effects operate within causal matrices of practices and institutions. In this way, although both Hacking and Haslanger look to shed light on the social construction of phenomena, and both view those phenomena as alterable, Hacking's account is descriptive, while Haslanger's account is normative.

Where Haslanger has an explicit social-political aim, Hacking's constructionist account has more of an epistemic aim that takes up the task of demystifying looping relations between objects and ideas, which he claims the social world is rife with. His account is chiefly concerned with revealing the *causes* at work. On his view, the relations of looping effects are genuinely causal properties which differentiate an interactive kind from what he calls an "indifferent kind" (1999, 119). An indifferent kind on his account is what is commonly referred to as a natural kind. What differentiates indifferent kinds from interactive kinds is that the former lack self-awareness, and therefore do not have looping effects. Examples of indifferent kinds on his view are quarks and microbes, which can be affected by our knowledge of them, but cannot act upon themselves in the ways that interactive kinds can.

Both Hacking (1999) and Haslanger (2003, 2012) argue that it is important to distinguish between idea construction and object construction, and both hold that social construction concerns the complex interaction between ideas and objects. Haslanger maintains that social construction is not *only* about causal processes and the social products they produce. Rather, on her account, how something is socially constructed matters too. Haslanger draws a distinction between causal construction and constitutive construction. On her account, causal social construction is determined by things such as actions and behaviours. Constitutive social construction, in contrast, is determined by essential reference to social factors. Because constitutive construction states essential social features it is a stronger type of social construction

than causal construction, which merely relies on causal feedback loops between classifications, attributions and individuals. Constitutive construction relies on the existence of particular social groups and their dynamics (though the dynamics of the particular in-group are able to change).

Haslanger uses the example of gender to highlight the differences between Hacking's and her own account. For Hacking, gender is both an idea and an object construction. Gender is an idea construction because the *classification* is the contingent result of historical events and social forces. Gender is a classification (or classification system). At the same time, the classifications *woman* and *man* are interactive kinds to the extent that they stem from an intricate matrix of practices and institutions. Being classified as a 'woman' or a 'man' bears significantly on an individual's life because women and men are constructed as gendered *kinds of people*.

Haslanger points out that, for Hacking, both the construction of *woman* and *man* as classifications and as kinds of people are causal constructions. The reason for this that his social constructionist account of gender focuses on explaining the causal construction of gender as a classification, i.e., a causal explanation of where the ideas *woman* and *man* come from, and his account focuses on where objects like gendered behaviour come from. For Hacking, both of these constructions are historically contingent and reinforced by institutions and practices. For Haslanger, a causal explanation alone is incomplete. Rather, she argues there are contexts in which the claim that gender is socially constructed is not causal but constitutive.

What is the difference? On Haslanger's account the difference between causal and constitutive construction in this case is that the ways humans classify gender goes beyond basing our classification system on anatomical or biological differences. Instead, our gender classifications also comprise a system of social categories that can only be defined by reference to a network of social relations. On her view, gender is not merely a concept used to refer to

bodies with certain kinds of appearances. Rather, the concept of gender is also used in the social world as an "analytical tool" to explain a range of social phenomena, e.g., differences in labour, perspective, or economic resources (Haslanger 2012, 131).

So, for Hacking, to say that something is socially constructed is to say that it is socially caused. For Haslanger, social kinds (like interactive kinds) are not necessarily the same as objects that have social causes. The reason she provides is that the conditions on account of which a social object exists are not necessarily what *caused* the object. To illustrate her claim, take the example of having a (non-honorary) PhD. Having a PhD means that one has been conferred a Doctor of Philosophy degree from an accredited university. The conferral of the degree is not what *causes* one to have a PhD (attending a PhD program, fulfilling program requirements, filling out forms, and successfully writing and defending a dissertation is what causes it). Instead, being awarded a Doctor of Philosophy from an accredited university is just what having a PhD *consists* in. Thus, on her view there is a non-trivial difference between what causes a social entity and what constitutes it. Haslanger, in contrast, views the difference between social and natural kinds as being not only a difference in the causal processes that give rise to them, but also a difference in constitutive relations.

Like Hacking, Haslanger is interested in the demystifying work that social constructionist analyses do for social kinds. As mentioned above, she argues that some kinds are *covert* social kinds, and social constructionist analyses can shed significant light on the ways kinds that we take for granted as natural are, in fact, social. Let's return to the example of *White woman*. We might take it for granted that to be a White woman just means that one has certain phenotypic characteristics, e.g., light skin colour. A social constructionist analysis of what it is to be a White woman, however, is likely to be socially and politically important and will reveal features about

networks of relations in the social world that are not necessarily transparent. Social construction can offer novel explanations about phenomena that might be surprising. Haslanger marks the distinction between causal and constitutive construction as follows:

> *X is socially constructed causally as an F* iff social factors (i.e., *X's* participation in a social matrix) play a significant role in causing *X* to have those features by virtue of which it counts as an *F*.
>
> *X is socially constructed constitutively as an F* iff *X* is of a kind or sort *F* such that in defining what it is to be *F*, we must make reference to social factors (or: such that in order for *X* to be *F*, *X* must exist within a social matrix that constitutes *F*'s) (2012, 131).

In other words, e.g., a man is causally constructed as a husband if and only if social factors (e.g., falling in love with a particular person, getting into a serious relationship, and deciding to marry them) play a key role in causing a man to have those features that count as a husband (i.e., being a legally married man). On the flip side, a man is constitutively constructed as a husband if and only if in order for a man to be a husband, a man must exist within a social matrix that constitutes the *kind* husband.

Haslanger's view goes beyond Hacking's to the degree that she underscores that the construction of social kinds involves more than causal relations. She claims, however, that emphasizing constitutive relations is what is central to spelling out the novel explanations that social construction can offer in revealing covert social kinds. It seems, however, that making explicit what causal relations are operative in covert social kinds can generate novel explanations about covert kinds too. The other, perhaps more compelling, reason Haslanger provides for why Hacking's causal view is too narrow is that social kinds do not bring about their own existence (they are not self-causing). To illustrate, take Simone de Beauvoir's famous claim that "One is not born, but rather becomes woman" (Beauvoir 1949). Haslanger argues that what Beauvoir's claim shows is not that an individual is caused to be feminine in virtue of social

forces, but rather the claim highlights that being a woman is a social matter, and not a matter of bodily structure.

On Haslanger's reading, what this quote underscores is that woman is a *kind* of thing that is constituted within a social matrix, and the existence of woman as a kind *depends* on a network of social relations and other social positions, viz., man. Thus, analysing the constitutive relations and not only the causal relations of social kinds can reveal various dependence relations between kinds, and not merely the processes that give rise to individual kinds. Haslanger views the difference between social and natural kinds as being not only a difference in the causal processes that give rise to them, but also a difference in constitutive relations.

The consensus among moderate social constructionists including Khalidi, Hacking, Haslanger, and Mallon is that at least some social kinds have causal powers. Hacking and Haslanger differentiate object construction from idea construction, and the core feature of Hacking's account of social kinds is that the causal relationships between object and idea construction can give rise to interactive kinds, which differ from other (natural and social) kinds that are influenced by humans but lack self-awareness, i.e., indifferent kinds. For Hacking, the causal processes for kind construction are not only key for differentiating kinds, but are also central to explaining how social construction functions in the world. Haslanger, on the other hand, views a causal account of social kinds as incomplete and holds that examining constitutive dependence relations is also crucial to pinning down how social kinds are constructed.

Even though Haslanger maintains that constitutive constructions are central to social kinds, Hacking describes her constitutive approach to gender as additive. In other words, analysing gender as a social category dependent on a matrix of social relations is a contingent "add-on" to human beliefs about the physiological properties commonly associated with

particular genders (Hacking 1999, 7-8). For Hacking, Haslanger's constitutive approach does not do much explanatory work for a concept of gender, given that he views gender as essentially a social construct, and thus spelling out that a social kind like gender is socially constructed is redundant. Haslanger (2012) responds to this claim by arguing that plenty of social kinds are covertly socially constructed, and so offering constructionist analyses of kinds can reveal that an object is a social rather than a natural kind. In the case of gender, for instance, it has only been since the second half of the twentieth century that the object and concept gender have been widely understood to be and pick out a social phenomenon. Before the second half of the twentieth century, what we now call 'gender' was categorically seen as equivalent with sex, which was thought to form a natural kind. As mentioned above, on Haslanger's part, engaging in social constructionist analyses that look at constitutive relations can provide novel explanations of phenomena and do the revelatory work that Hacking is interested in.

6. Real Definition

Constitutive construction is a stronger form of social construction than causal construction because social features are treated as essential to what a social kind is. Moreover, constitutive construction does not rely on features of mind-dependence as indicative of something's being a social kind; rather, social kinds are social by definition and the particular causal factors associated with the kind are *not what* makes the kind what it is.

At this juncture, I'll situate where my view is positioned in the kinds debate. In Section 2. I described the so-called traditional approach to natural kinds theory and highlighted that essences are necessary features of such kinds. It is important to note, however, that modal accounts of essence are not the only essentialist framework for theorizing about kinds. Kit Fine (1995) offers a non-modal account of essence in terms of real definition. Real definitions

contrast with nominal definitions in the sense that the essence of an entity adheres or 'resides' in its real definition and to define an entity (to state its essence) is to say what it is. Nominal definitions, on the other hand, are merely verbal. Fine's non-modal account of essence differs from modal accounts because the former does not assert that an entity holds any property by necessity, which arguably diffuses some criticisms from HPC and SPC kind theorists. Fine's non-modal account also permits essentialist approaches to biological and social kinds without the restrictions of 'traditional' modal approaches for such kinds since essences on this construal are not intrinsic, modally necessary, or microstructural properties of individual kind members. In Chapter V, I'll offer my account of sex's real definition as constitutively biological from the perspective of development. My real definition does not assert that any particular arrangement or developmental trajectory of genes, gonads, genitals, hormones or morphology is essential. Rather than appealing to trajectories in sex development as my causal analysis accounts for, merely some arrangement of what I call 'sex-based' properties are features of human sex development and are constitutive.

7. Conclusion

For the purposes of my account, both causal and constitutive properties are relevant in accounting for socially significant biological kinds, to which I will return to in Chapters II and V. Accounting for the particular causal changes of a kind's properties are important for capturing the phenomena of a kind. In this chapter, I have focused on some of the central differences between traditional natural kinds, biological kinds analysed through HPC and SPC kind theories and social kinds. The purpose of doing so was to show that these are kind theories that explain a range of phenomena, such as special science phenomena that includes chemical phenomena, biological phenomena, and social phenomena, respectively. This clarifying work is in service of

the first part of my project. In Chapter V, I'll explain why I think sex is best understood as a biological kind rather than a natural kind or a social kind. The metaphysical question, "What is sex?" is a controversial one for methodological and moral reasons, e.g., some feminist scholars argue that it is the wrong question to ask because attempting to 'get the answer right' risks reinforcing a sex-gender[22] binary (Cruz 2010; Stirnitzke 2011). In Chapters V and VI, I'll present why there is nothing inherently (epistemically or morally) harmful about asking and answering this question, but I'll stress that in attempting to get the answer 'right' the content of our normative aims matter.

[22] Throughout this project, I'll use *sex-gender* to mark instances of conceptual *conflation* between sex and gender, and *sex/gender* to track a *distinction* between the two categories or concepts.

Chapter II: From Biological Kinds and to Conceptual Engineering

1. Introduction

In this chapter, I am concerned with how studying socially significant biological kinds can contribute to ameliorating the human lives they cut across. Here I'll present my account of biological kinds, which along with my analyses in Chapters III and IV of sex concepts and models in scientific research, will help set the stage for the first aim of this project, which is my positive claim that sex is a biological kind. This chapter also sets the stage for the second core aim of this project, which is the claim that sex as a kind supports the engineering of a deflationary SEX concept. I'll also show how other candidates for biological kinds, viz. the socially significant biological kind health, are amenable to conceptual engineering. Conceptual engineering is a novel approach to thinking about concepts, and can be contrasted with traditional conceptual analysis insofar as the former involves rejecting or revising one's current concept, whereas the latter merely makes explicit one's current concept through intuition. Conceptual engineering involves discarding or changing a concept for particular aims. The aims that will be briefly articulated in this chapter are epistemic and social-political aims. One of the primary goals of this chapter is to show that biological kinds can be responsive to social-political aims. In this chapter, I shall also begin to sketch how my metaphysical account of socially significant biological kinds is compatible with conceptual engineering.

2. Biological Kinds

In Chapter I, I defined biological kinds as groupings of biological organisms that have some properties in common that enable robust generalizations. Building on the previous discussions of natural, biological and social kinds, I offer an analysis of biological kinds that

highlights their social significance. Socially significant biological kinds have feedback loops that function in similar ways that Hacking's (1999) looping effects do. My analysis of socially significant biological kinds differs from Hacking's (1999) interactive kinds in the sense that self-awareness is not required in order for causal looping to take place. Instead, all that is needed is that a causal interaction between biological and social properties produces a looping effect—self-awareness in an individual agent is not required. For example, depression is a phenomenon that occurs without individual agents necessarily being aware that they are depressed. In the case of biological kinds, feedback loops can involve properties that are both biological and social, and these biological and social properties are able to act on each other. In the case of socially significant biological kinds, biological and social properties interact in ways that can influence kind membership or give rise to new classifications or behaviours. The causal biological and social features of such biological kinds function together via compound causal mechanisms.

For instance, in the case of disordered eating, one can have a genetic predisposition towards developing an eating disorder, but such a disposition relies on certain environmental stimuli being instantiated. In the case of anorexia nervosa, eight genes have been identified with a strong link to the development of anorexia, and anorexia nervosa is now considered to be a metabolic as well as a psychiatric disorder (Watson et al. 2019). Environmental stimuli that contributes to the development of anorexia might be exposure to a culture that highly values thinness or tightly controlled eating practices. If disordered eating is a socially significant biological kind, the interaction that occurs between the biological feature of the predisposition and the known social value gives rise to the eating disorder. Overtime, the eating disorder can augment certain biological, psychological and social features of the individual who has it. The genetic predisposition alone and the social value alone, e.g., as represented via media exposure

or peer/family pressure, do not account for the expression of the eating disorder—they act together in ways that cause the eating disorder to be expressed, which in turn can alter other biological and psychosocial properties of the individual.

The ways that biological and social properties act together to change or form new classifications or behaviours is what marks the difference between biological kinds with socially significant features and biological kinds such as single-cell organisms. As stated above, biological kinds can have hybrid causal features that produce effects that are not necessarily the sum of their separate causes. In other words, the relations between some of the biological and social features of biological kinds are not simply additive. Rather, they are dynamic relations that have their own causal influences. The ways that some biological and social properties interact to change kind membership or generate a classification or behaviour cannot be explained fully by the individual causes alone. It is the dynamic interaction that is potentially more fruitful.

To further illustrate why the notion of a socially significant biological kind is indispensable to explaining certain kinds of biological and social phenomena, let's consider health as a kind. Some researchers and theorists define health as an entirely descriptive category, while others define it as a staunchly normative category imbued with culture and politics. These two camps can be referred to as naturalistic vs constructionist approaches to health. One naturalistic approach defines health as merely the absence of disease (i.e., where disease is viewed as a functional impairment or failure of physiological or psychological functioning). Thus, on this naturalistic definition, if health is merely the absence of disease, then health is a state of normal biological functioning. Other naturalistic approaches, however, view health not merely within a negative framework (an absence of disease), but within a positive framework

where health is physical, mental, and social well-being. The World Health Organization (WHO) defines health in this positive sense (1948; Murphy 2020).

This sort of naturalistic approach places greater emphasis on a notion of health as normal functioning. On the flipside, a constructionist approach emphasises the role of human practices in labelling a condition as healthy or diseased. Rather than viewing health and disease states as belonging to purported biological classes of poor functioning or abnormality, a constructionist might hold that health and disease are defined by our values and practices. In general, a naturalistic approach offers the insight that health status involves causal processes that includes biological functioning. When it comes to health, however, the overall frameworks of both the naturalistic and the constructionist approaches are lacking. Naturalistic and social constructionist approaches are too narrow in the sense that they do not account for the interactions between biological functioning, social environment and social labelling. A tenable concept of HEALTH requires that both biological and social properties be taken into account plus the effects their interactions produce.

3. The Biological and Social Interactions Involved in Telomere Attrition

A key aspect of health and longevity, telomere length, is a good case study for highlighting the biological and social features of health as a kind. Telomeres are repetitive sequences of DNA that serve as the caps at the end of chromosomes. They protect chromosomes from cellular damage and support chromosomal stability.Telomeres function much like the plastic caps at the end of a shoelace, which serve to keep the shoelace from fraying. Telomeres break down during cell replication, which results in shorter telomere length overtime and a negative correlation with chronological age. Several studies show that

psychosocial and physiologic stressors can precipitate telomere shortening (Epel 2020).

Telomere length is a determinant of cellular senescence[23] and longevity. Senescence plays an important anti-tumorigenic role in the body and has some beneficial functions such as contributing to wound healing, the onset of senescence triggered by shortened telomeres promotes age-related diseases and shortens longevity. Senescence is a DNA damage response. Telomere length is taken to be a progressive marker of "wear and tear" at the cellular level (Epel 2020; Geronimus et al. 2010; Monaghan 2010). In particular, leukocyte telomere length has been identified as an indicator of immune system ageing as well as general systemic ageing of the organism. In addition leukocyte telomere length has been linked to multiple ageing-related health statuses, viz., cardiovascular disease, metabolic syndrome, osteoporosis and osteoarthritis, cognitive decline, and mortality (Blackburn et al. 2015).

Biologist Elizabeth Blackburn and psychologist Elissa S. Epel (2017) have conducted empirical research on the effect of telomeres on human health and longevity. Their research shows that chronic stress from the social conditions that trigger it such as poverty, food insecurity, or late-night shift work lead to shortened telomeres, and thus to a shorter lifespan and health complications. Epel's (2020) study on racial discrimination and telomere shortening in African Americans shows that racial discrimination contributes to accelerated physiological ageing and health declines. Epel's and colleagues' study shows that the psychosocial phenomenon of racial discrimination impacts the biological systems (e.g., telomere length) of African Americans, which leads to negative impacts on health status and lifespan. For African

[23] Cellular senescence is a state of stable cell cycle arrest (i.e., the point at which a cell cycle is no longer involved in duplication and division and becomes resistant to growth-promoting stimuli). Basically, senescence blocks the replication of cells possessing damaged DNA and is induced by telomere shortening (amongst other damaging stimuli).

Americans, racism is a psychosocial stressor that contributes to health disparities including adverse disease outcomes (e.g., inflammation and oxidative stress) and accelerated biological ageing.

Psychologist Danielle L Beatty Moody's et al. (2014, 2021) research has found that everyday discrimination is a social determinant of health, particularly in terms of cardiovascular disease risk (e.g., stroke risk) amongst African Americans. Social determinants of health are the social and economic factors (e.g., poverty, wealth, and early life experiences) that influence a person's health. Beatty Moody et al. (2021) define racial discrimination as the direct interpersonal experience of unfair treatment due to membership in a particular social group. In a sample of middle-aged and older African Americans, they identified interaction effects between interpersonal-level discrimination, depressive symptoms, and early stage carotid atherosclerosis (carotid artery disease). In particular, they found that African Americans reported either experiencing "greater exposure to discrimination across multiple sources" or "greater lifetime discrimination burden" along with increased levels of depressive symptoms, greater carotid intima-media thickness (CIMT) than those reporting lower levels of discrimination or depressive symptoms (Beatty Moody et al. 2021). Higher CIMT measures indicate vascular disease. Racism is a psychosocial stressor among African Americans that contributes to the occurrence and severity of multiple negative health statuses, which may be induced by accelerated biological ageing.

In addition to carotid artery disease, studies have found links between racial discrimination and various markers of inflammation including glucocorticoids, which are a type of steroid hormone that act on inflammation, and proinflammatory cytokines, which are proteins involved in the up-regulation of inflammatory reactions (Williams 2018). Other research has

discovered that African American adolescents who report consistent high levels of racial discrimination over time were found to have greater allostatic load (i.e., 'wear and tear' on the body and brain that results from being stressed out) (Chae, et al. 2020). What's more, elevated allostatic load has been found to effect African American women reporting higher levels of racial discrimination (Upchruch et al. 2015), and another recent study has found that racial discrimination may be linked to epigenetic ageing (Brody et al. 2016). Inflammation and other biological stress mediators like oxidative stress are thought to contribute to telomere shortening. The emerging consensus is that racial discrimination may be tracked biologically through its effects on the telomere maintenance system. Similar to the social stressor poverty, racial discrimination experienced by African Americans is an environmental stressor that causes telomere shortening. Damaged telomeres lead to degenerated health and lifespan outcomes. For African Americans, racial discrimination leads to negative health status through social *and* biological mechanisms that are exhibited through telomere shortening.

The psychosocial phenomenon of racial discrimination has measurable biological effects. We can understand health to not only have biological causes, e.g., genetic or hormonal causes, but also epigenetic causes spurred by social factors. As the case of telomere shortening in African Americans shows, a social phenomenon[24] like racial discrimination can literally change one's biological properties—where such a change in properties would be less likely to occur otherwise. That is, as an African American, experiencing racial discrimination leads to an increased likelihood of developing cardiovascular disease compared to White Americans. Viewing the causes of telomere shortening amongst African Americans to be comprised of solely

[24] Racial discrimination is a social in the sense that it relies on the explicit or implicit adoption of pejorative social meanings of what it is to be Black or African American, and associations of certain physical or social markers, e.g., skin colour or given name with being Black or African American.

biological factors would offer an incomplete analysis of the mechanisms at play. In light of this case study, what is needed to adequately assess what human health is an analysis that includes both biological and social causal mechanisms, and importantly, how both types of mechanism work together to result in particular human health statuses. The effects of racial discrimination on telomere length is an example of why health is best understood as a biological kind with significant social (or psychosocial) causes.

It is worth highlighting further that telomere shortening brought on by social stressors can not only lead to phenomena like greater allostatic load, but social stressors like racial discrimination in African Americans can literally alter an individual's gene expression. That social factors can alter gene expression is especially significant because this amounts to an instance of a social phenomenon causing changes to what are widely considered as fundamental (or lower-level) biological properties—the most stereotypical biological properties. For instance, the expression of the human TERT[25] gene is regulated in part by telomere length (Kim and Shay 2018). When telomeres are long the hTERT gene is repressed. The hTERT gene is located on chromosome 5 and codes for telomerase, which is crucial for the replication of chromosome termini (DNA ends). Telomerase is a protein enzyme complex that adds telomeric repeats at the ends of chromosomes, and is active in progenitor and cancer cells. Telomeres are wholly maintained by telomerase in human embryonic stem cells, which is expressed in early fetal development. Telomerase partly manages telomeres in adult stem cells, but is turned off in most adult tissues. It is then reactivated in nearly all human cancer cells (Kim and Shay 2018).

The precise biological mechanism that turns telomerase expression on or off is currently unknown, but geneticists Wanil Kim and Jerry W. Shay (2018) may have isolated a mechanism

[25] TERT stands for telomerase reverse transcriptase. hTERT is one component of the telomerase enzyme that transcribes RNA to DNA in humans.

which they refer to as telomere length dependent loops (TPE-OLD), or, telomere looping, that regulates gene expression without telomeres being spatially located near genes (in the subtelomeric region) that switch on. Telomerase in adult cells may be regulated partly by telomere looping. Usually, in order for telomeres to bring about changes in gene expression, said genes need to be located close to chromosome ends. When telomeres catalyse changes in gene expression in proximate genes, these changes can be understood as telomere position effects (Kim and Shay 2018). Telomere looping, however, can also bring about alterations in gene expression. Telomere looping occurs when changes in gene expression take place in genes that are located outside the subtelomeric region. The notion that cumulative telomere shortening overtime can regulate changes in gene expression at genomic sites at outlying distances from a telomere represents a novel mechanism (Kim and Shay 2018). Telomeres loop to chromatin[26] near distal genes. Genes affected by telomere looping are usually repressed in cells with long telomeres, but are expressed in cells with shorter telomeres. For example, when telomeres are long the hTERT gene is repressed and shares a regulatory locus (co-localized) with the telomere. For telomere looping, however, when telomeres are short at least one of the hTERT alleles lies outside the subtelomeric region and triggers changes in DNA methylation.[27] Cells with long telomeres have a repressed hTERT epigenetic states (chromatin and DNA methylation), but both of these epigenetic states are altered when telomeres are short, and this epigenetic alteration triggers changes in gene expression (e.g., in the hTERT gene and nearby genes) (Kim and Shay 2018).

[26] Chromatin is a DNA and protein complex. Changes in chromatin structure are linked with DNA replication and gene expression.
[27] DNA methylation regulates gene expression generally by recruiting proteins involved in gene repression, but in some cases can be involved in transcription activation. DNA methylation can fine-tune gene expression. During DNA methylation structures called methyl groups are added and removed along the length of DNA.

Telomere looping is a new and possibly significant epigenetic mechanism. Telomere looping does not only play a role in altering gene expression during human ageing (repressing certain genes when telomeres are long and activating gene expression when telomeres are short), but also in the proliferation, differentiation or activation of cancer cells and immune cells (regardless of telomere length). Kim and Shay (2018) maintain that a more comprehensive understanding of the epigenetic regulation of gene expression during transient telomerase activation and age association activation would better enable researchers to explain the mechanisms involved in the *in vivo* regulation of telomerase. The fact that social causes lead to biological effects (like the development of cardiovascular disease) serves as potentially significant evidence for the notion that health may be constitutively biological but has important social causes. Moreover, the case of telomere shortening serves as further support for my proposal that health is such a biological kind because as stressors shorten telomeres, telomeres influence gene expression through telomere position effects and the newly discovered mechanism of telomere looping. Shortened telomeres influence gene expression that triggers cellular senescence and reduces human longevity. The upshot is that social stressors can have damaging biological impacts in the form of epigenetic effects that lead to increased allostatic load, and on gene expression that catalyzes the development of cancer.

Just as empirical discoveries about biological kinds can change biological concepts, discoveries about a biological kind can change our concept of the kind. Similarly, employing a new concept of a social kind, e.g., MARRIAGE, can change the composition of kind membership (and the kind itself). What is unique about the bi-directional causal mechanism of biological kinds is that biological and social properties can interact to a point where a psychosocial change (like concept usage) can alter the kind's social *or* biological properties. That

a change in concept usage has the potential to alter the biological properties of a biological kind speaks to the robustness of the causal relationships between the biological and the social (viz., social environment), and to the flexibility of biological kinds.

4. Biological Kinds and Conceptual Engineering

Here I shall sketch what conceptual engineering is and why it is important to kinds. I'll consider why and how the function of a concept plays a key role in unpacking the relationship between kinds and concepts. Conceptual engineering is a metaphilosophical and philosophical approach that examines the normative and evaluative dimensions of concepts. Conceptual engineers are philosophers and non-philosophers alike, and they evaluate the adequacy and functions of a given concept (Plunkett and Sundell 2013). I take a concept to be a tool that represents phenomena by virtue of mental content.

Concepts, like IKEA wrenches, can be defective or just the wrong one for the job. A concept is defective if it fails to do the representational work for the task. Like hex keys, some concepts are a bad fit. When concepts are flawed or an ill match we can alter or engineer a brand new concept—one that works and is appropriate for the particular job at hand. A concept that *works* is one that fulfills its function as a representational vehicle for a specific target.

The engineer chooses what the target is. If a concept is defective, the conceptual engineer opts to revise or replace the old concept with an improved or new concept. Conceptual engineering enables us to revise or replace concepts for a particular purpose. The purpose may be moral, social or political such as in the case of the shift in usage from "coloured people" to "minorities" to "people of colour" in the last sixty years in the United States. Not only does this shift pick out a terminological change but a conceptual change as well—one that consists of a shift of extension with a more inclusive membership and that is not defined strictly in contrast to

being White. In such a case, the engineer can explicitly insist on using the new concept in favour of older ones for social-political reasons.

Moreover, conceptual shifts can occur for empirical and epistemic reasons, and the conceptual engineer can move to improve or change a concept in light of epistemic aims. For instance, in the mid-twentieth century technological and experimental discoveries in molecular genetics led to a transition from the classical gene concept to the molecular gene concept. This shift in concept usage involved a change of meaning and extension in light of the epistemic goals for gene concept usage in the scientific community (Brigandt 2010; Prinzing 2018).

Conceptual engineering can be traced back to Rudolf Carnap's (1950) notion of explication, and found in contemporary revisionary projects such as Sally Haslanger's (2000, 2012) work on ameliorative and analytic projects for non-epistemic (social-political) aims. Herman Cappelen (2018), Matti Eklund (2015), and Kevin Scharp (2013) explicitly use the label 'conceptual engineering,' and Alexis Burgess and David Plunkett (2013a) favour the term 'conceptual ethics' to represent their analysis of the normative and evaluative dimensions of concept usage. In addition to Carnap who was concerned with revising or replacing inadequate concepts or terms within ordinary language for reasons of vagueness or imprecision, Haslanger's project focuses on ameliorating concepts such as GENDER and RACE for social-political purposes.

At first blush, a concept that works also matches the world. It represents some aspect of the world accurately. This is a good starting point for delineating what a proper function of a concept is, but this notion of concept-to-world fit is too coarse-grained. Concepts do more than fit the world, and a well-engineered concept can serve additional purposes. Which aspects of the

world a concept represents and for what reasons is crucial. We can use concepts to represent the relevant aspects of reality depending on what sorts of inquiry, activity or talk we are engaged in.

With regard to race, Mallon (2004) argues that instead of focusing on ontological questions and questions about the meaning of race concepts, we can instead focus on the kinds of conceptual tools we need to discuss racial classification and associated phenomena. He favours building an adequate metaphysical theory that can differentiate between accounts of race or racial phenomena to cater to our functional needs, which for race encompasses racial identification, experience, appearance and folk classification. For Mallon (2004), we need the right conceptual tools to be able to fruitfully discuss the practical, social and ethical importance of those different functions of race. Thus by Mallon's (2004) lights, sorting out the right concepts of RACE to use is a project in refining our theories (about race) that can aid in eliminating the errors of our ordinary thinking (about race) *and* preserves our ability to refer to the world in ways that meet a plurality of theoretical requirements (Mallon 2004, 669).

Mallon does not use the label *conceptual engineering* to demarcate his approach to assessing what is most important in the debates about the social construction of race, he effectively advocates for what is now called 'conceptual engineering.' What is significant about Mallon's (2004) account of race is that he underscores that the ontological question of race is of lesser importance to our goals of making sense of race as a classification system and phenomena. Instead, what is critical is the ability to successfully theorize about race, which depends on whether and how our concepts are meeting our theoretical needs. The central takeaway here is that concepts can work not only within but *for* our theories such that they can do more than represent or bear content. Concepts do more than descriptive work within our theories, they can

do normative work as well. In other words, concepts can represent what is relevant about aspects of reality in light of a particular question or discussion.

An adequate concept is one that accurately represents content, but also motivates explanations and action. For instance, adequate concepts enable us to elicit the causal mechanistic relations among phenomena in order to yield better explanations and make useful predictions. In addition, adequate concepts enable us to better understand phenomena, which can empower us to intervene and rectify problems.

For a natural kind like water, our concept of water should track its chemical property H_2O (and, in doing so, its dispositional properties like *wet*, *liquid, solid* and *vapour*).[28] For a biological kind like health, our concept should be able to capture health's biological and social features, but also be flexible enough to be responsive to normative aims such as social-political aims. An adequate health concept needs to be flexible to accommodate all the relevant biological and social aspects of health, which are subject to change for individuals and populations over time and across circumstances.

On the other hand, an adequate concept of water is rigid in its representation of water because its proper function is to track water's chemical properties through its dispositional changes. Not only is a good concept of water rightly rigid for empirical reasons, but it's good for practical reasons as well—it can be dangerous if someone mistakes another substance (e.g., an aqueous solution of sodium hydroxide) for water. For practical and theoretical reasons, we

[28] Michael Prinzing (2018) argues that the function of water is not to track its microstructural properties, rather the concept's purpose is to track "watery stuff" without respect to its essence. He argues that *uses* of concepts can track the extension water, but functions track water as a substance. However, because water is a natural kind, and it's been discovered that water has the microstructure H_2O, I suggest that our concept of water has changed to accommodate this revelation. And that tracking water as a "substance" means that we are tracking H_2O. The concept *water* does track "watery" stuff but also excludes substances that are not water. I suggest that it is part of the function of the concept water to track what *is* in fact water.

should want our concept of water to track only H_2O and *not* NaOH. Like water, getting our concept of HEALTH 'right' is a matter of empirical, epistemic and practical significance. In the case of health, however, other normative considerations such as moral and social-political ones are also important.

An adequate concept of HEALTH not only represents the biological and social aspects of health, but enables us to both understand and act to change the biosocial causal mechanisms that give rise to health disparities in order to alleviate those disparities. Introducing a new concept, if more adequate than the current concept, has epistemic advantages but can also have important moral, social and political advantages. Providing a concept of HEALTH that takes into account its biological and social components in the context of diverse human modalities might well be epistemically and practically advantageous, but providing such a concept could be socially and politically advantageous too. That is, a concept of HEALTH that takes into account the best empirical findings and how those findings fit with, e.g., social-political disparities between groups would be more empirically adequate, and thus epistemically advantageous. It would also be a concept that would answer to specific social and political aims of emphasising key differences between groups and individuals, rather than ignoring them.

It is important to emphasize such differences because social-political context plays a crucial role in health status. For example, in employing a concept of HEALTH in a US context, it would be morally appropriate to capture health disparities related to race, gender, disability, sexual orientation and class. It has been well-documented, e.g., that Black, Latinx and transgender persons experience health disparities and disparities in health care compared to White or cis persons (Riley 2012, Safer et al. 2017, Taylor 2019). For Black, Latinx or trans persons, experiencing a health disparity means that one has a higher burden of illness, injury or

mortality than White or cis persons. Health care disparities refer to differences between groups in access, use or quality of health care. In the United States, a disparity in health care also refers to a difference in health insurance coverage. An empirically adequate concept is important to epistemic aims, but a concept that also meets social and political aims of justice and equality is significant too because not only does it help us achieve the aims of true representation, prediction and explanatory power, but it also aids us in maneuvering the necessary social and political mechanisms to promote better health statuses for everyone. If we care about addressing inequalities in health status and health care, then offering a concept of HEALTH that meets goals to eliminate disparities seems important. In view of the evidence that health and health care disparities have social and political causes, an adequate concept of HEALTH would need to respond to only epistemic and practical aims, but social and political aims as well.

I propose conceptual engineering as the best way forward in addressing the problem of our current concepts failing to capture the nature of socially significant biological kinds. When concepts about kinds do not match the kinds themselves, i.e., the concepts represent the kinds inaccurately and those concepts do not grasp the relevant aspects of the world, this is sufficient reason to abandon a concept. If the current concept in use, however, is also contributing to moral or social-political harm, then the reasons to abandon the current concept are necessary and sufficient.

For my current purposes, I shall offer some methodological reflections on how to engineer an adequate concept for a biological kind. In doing this, I'll sketch some general criteria for what an adequate concept for a socially significant biological kind—given its nature—should look like. Because biological kinds are discoverable, the empirical facts relevant to the kind should be accurately represented, and a new concept should be able to capture the kind in a way

that enables us to explain how the kind functions in the world. Representational accuracy and explanatory aims are of core significance in offering a new concept for such a kind.[29]

Furthermore, because the empirical facts are both biological and social, accurately representing those facts or being able to offer explanations with respect to them is not merely an epistemic endeavour, but also serves social-political aims. The particular social-political aims of an adequate concept may differ, eliminating or (at least) reducing harm is a core social-political aim because it cuts across various aims including justice, fairness, recognition and empowerment. Like representational accuracy and explanatory aims, the aim of preventing harm needs to be relevant and legitimate for every adequate concept of the kind. Some social-political aims may be relevant and legitimate specific to particular concepts, but not for every adequate concept of a biological kind. For example, the aim of emphasising difference for social or moral purposes might be relevant and legitimate for concepts of HEALTH that allow for comparisons between Black and White patients in health care settings, but not relevant or legitimate when it comes to race-based comparisons in cognitive function. What counts as a legitimate aim is disputable and not everyone will be convinced of a new concept's relevancy or legitimacy, but clarifying who experiences harm and what causes it is partly an empirical matter—not merely one of analysis. For this reason, the aim of preventing harm can be justified in a more clear-cut, less disputable manner, which bolsters its credence as a core aim.

Applying the core epistemic and social-political aims of representational accuracy, explanatory power, and prevention of harm is a key starting point to engineering an adequate concept for a socially significant biological kind. One might challenge that engineering a new

[29] Adequate concepts may serve other epistemic aims like investigative or classificatory aims, but it's possible that these aims may not be relevant or as central to every adequate concept of a kind. My claim here is that representational accuracy and explanatory aims will be relevant and crucial to every adequate concept of a socially significant biological kind.

concept for a kind is an arbitrary or motive-driven endeavour. Socially significant biological kinds are the types of thing that not only enable new concepts to be created about them, but can require us to generate a concept to capture their alterations, i.e., if we are invested in explaining and representing the world and its transformations accurately.

For example, the influx of immigrant populations in a larger community may change what the health status (and health care) of the larger community looks like. Immigrant populations may not receive the same quality of care or access to care that others in the larger community experience. In this instance, although the constitutive properties of health have not changed, the causal properties that influence health outcomes have changed in the community thus calling for an improved way to think and talk about health that targets those changes.
A new concept that has as its foundation the relevant and verified empirical facts and that serves at least the core aims is not arbitrary, but is objectively warranted. The reason for this is that the world puts constraints on conceptual engineering. And given the constraints, one cannot offer a new concept that is adequate at random. Rather, to ensure its adequacy, the new concept will need to be based in reality. Philosophers, scientists and social theorists can get things wrong about reality, but this is why applying the core aims, rigorous empirical fact-checking, integration and interdisciplinary engagement, and the incorporation of the appropriate normative values is important. Moreover, being 'motive-driven' is not necessarily a weakness of conceptual engineering. Rather, having a particular agenda is central to engineering a new concept for particular purposes. The potential problem for engineering a concept is not that it is fuelled by an agenda, but a potential problem lies with the contents of one's agenda.

5. Conclusion

This chapter explored how biological and social phenomena act together in ways that causally influence biological kinds. Employing a new concept of HEALTH, for instance, in an immigrant community whose health statuses and particular needs have been overlooked by the larger society potentially can have effects at the genetic level by reducing the rate of telomere shortening. I am interested in the relationship between biological kinds and conceptual engineering because I am not merely concerned with providing a metaphysical description of what biological kinds are or the causal features of their particular members, but also in how specifying their nature can create opportunities for conceptual intervention that would not change the constituent properties of the kind but could change some their causal features for normative benefit.

As I claimed in Section 4 of this chapter, getting our concepts for scientific kinds 'right' is a matter of empirical, epistemic and practical significance, but when those concepts impact our moral, social and psychic lives, then moral and social-political considerations should be brought to bear as well. In Chapters V and VI, I'll return to the controversial issue of why it's important to 'get sex right' partially through specifying what it is. I shall contend that getting clear on the *what is it* question for sex is a crucial step for changing the baptismal SEX concept(s) embedded in our institutions, which too often are informed by biological determinism. Chapters III and IV will present and analyse such deterministic views in the biology of sex as well as gender-based brain studies. In those chapters, I'll also highlight alternative theoretical approaches to sex development.

Chapter III: The Biology of Sex—A Conceptual History

1. Introduction

The history of SEX concepts in the biology of sex has not followed a rational or linear progression. Instead, this history is rife with fortuitous twists and turns. In this chapter, I unpack

the history and usage of SEX concepts in the biology of sex spanning the early twentieth century to the present. Here I'll contend that there is overwhelming evidence that sex has a biological basis, i.e., humans have sex-based biological properties. In this chapter, I'll begin to sketch my causal account of sex development, which I shall develop further in Chapters IV and V. After I offer my conceptual history of SEX concepts, I'll present and argue against what I refer to as Simon Baron-Cohen's (2003) *causal inclusion thesis* for genetic and hormonal effects on sex development by arguing that the causal powers associated with sex-based properties are multiply realized. My discussion of sex's causal powers in this chapter are important to my further criticisms of Baron-Cohen's causal picture of sex development in Chapter IV, and in offering my alternative metaphysical account in Chapter V.

2. Sex Chromosomes

In this chapter, I shall maintain that conceptualisations of sex in the biological sciences, particularly post mid-twentieth-century, are a consequence of multiple contingent factors—viz., the molecular revolution in genetics, adaptationist agendas in evolutionary psychology and an overarching preoccupation in both scientific and public discourse to explain biology and behaviour by genes alone. I'll focus on those contingent factors operating in the history of sex classification except for adaptationist agendas in evolutionary psychology, which are beyond the scope of my project since they have a reproductive rather than a developmental focus.

Here I shall examine historical and contemporary research on sex development from the perspectives of genetics, endocrinology and evolutionary biology, largely drawing on research

conducted by early twentieth-century geneticists Thomas Hunt Morgan and Frank R. Lillie, who endorsed a hormonal model of sex development that relies on genetic information. I'll also examine the shift from classical to molecular genetics in the twentieth-century, and discuss the rise of the (molecular) chromosomal sex concept. Psychologist Simon Baron-Cohen (2003) invokes the notion that sex chromosomes (XX and XY) may be a major determinant of brain sex and of sex hormone secretions (2003,113), but there has been considerable scientific disagreement over the explanatory power of sex chromosomes in sex development.[30] At the end of this section, I'll outline why explanatory approaches beyond those from molecular genetics are necessary for adequately making sense of sex development.

3. Sex Chromosome Concepts and Terms

Chromosomes are bundles of DNA that are stored in the nucleus of a complex organism's cells. Furthermore, chromosomes come in homologous pairs, which divide and assort independently amid cell division. The human organism has twenty-three pairs of chromosomes received from gametes (egg and sperm). The chromosomes house strands of DNA specific to each chromosome. In the case of twenty-two out of the twenty-three sets, the two chromosomes of the set are nearly identical, while the twenty-third pair can display an XX pattern but also an XY pattern.

From the early to mid-twentieth-century the sex hormones and sex chromosomes emerged as key features of development and heredity. The X and Y chromosomes, initially called the "odd chromosomes" were discovered independently by geneticists Nettie Stevens and Edmund Beecher Wilson in 1905. In 1906, Wilson coined the term "sex chromosome." Other terms such

[30] Contemporary scientists, psychologists, science studies scholars: Anne Fausto-Sterling (2012), Joan Roughgarden (2004), Rebecca Jordan-Young (2010), Sarah Richardson (2013), Cordelia Fine (2010, 2017), Laura Hake and Clare O'Connor (2008), Claire Ainsworth (2015, 2017), and Lesley Rogers (2002, 2011) claim that sex hormones do not necessarily play a determining linear-hierarchical role in sex development.

as “accessory chromosome,” “heterochromosome,” and “idiochromosome” served as popular alternatives until the 1920s. For Wilson, it was “convenient” (but not essential) to refer to the X and Y chromosomes as “sex chromosomes” or “gonochromosomes” (relating to the gonads) (Wilson 1907). By the 1930s the term *sex chromosome* became the favoured term for X and Y chromosomes, few geneticists in the early twentieth-century viewed the *sex chromosome* as sex-determining, but rather understood sex development to be “a labile process which may be changed by a variety of influences” (Montgomery 1910).

In 1902, geneticist Clarence McClung proposed a metabolic explanation for the difference between the twenty-third chromosome pair. He advanced that the X chromosome acted as a flexible, selective mechanism that ultimately determines a fertilized egg’s sex as an adaptive response to cytological and environmental factors (McClung 1902). On McClung’s view, the X determines sex by accelerating metabolism, which he speculated was male determining. Along with other prominent theories of sex determination in the early twentieth-century, McClung’s model of X-chromosomal sex determination included environmental and cytological (cellular) components. On his account, the X chromosome functioned to aid the egg in choosing among female-producing and male-producing sperm. That is, McClung took the X to be a flexible, selective mechanism that enabled the egg to single out sperm that contained the X or the Y chromosome in response to environmental considerations (in this case, to select for the sex that was “most needed by the species” at a given time) (McClung 1902). Science historian Sarah S. Richardson notes that the discovery of a link between sex and the X and Y chromosomes did not convince biologists at the time that X and Y chromosome patterns determined sex, and biologists were sceptical of the idea that “maleness” and “femaleness” were distinct genetic characters exemplified by the X and Y (Richardson 2013, 40). Further, the discovery of the link between

the X and Y chromosomes with sex was, at best, thought to explain a subclass of sex determination in nature; however, an analysis of systems of sex determination in multiple phyla revealed to researchers that there existed no single, unified theory of sex (or of chromosomes in relation to sex).

Instead, the standard conception of sex was developmental and externalist (i.e., sensitive to interactions between genes, cytoplasmic, and environmental factors). The leading theories of the early twentieth-century, put forward by geneticists Wilson, Stevens, McClung, and Thomas Hunt Morgan, assumed a model of sex development that was flexible, complex, and nondeterministic. At the same time, however, Stevens and Wilson were interested in the notion that the X and Y chromosomes played a unique role in sex development and attempted to link the X and Y to Mendelian heredity. Even though Stevens and Wilson were externalists because they held that genes were not the sole determinants of sex, they maintained that the X and Y chromosomes are *sex* chromosomes, whereas Morgan was wary of postulating that the X and Y chromosomes are tightly linked to any notion of sex *qua* sex.

The 1910s-20s saw a shift from a metabolic model of sex determination to a hormonal model. The hormonal model served to ground chromosomal sex and was taken to play a primary role in sex determination such that phenotypes associated with secondary sex characteristics were held to be determined by hormones. Moreover, the hormonal model served to cement the chromosomal theory of sex as a compelling scientific theory. In emphasizing the roles of the X and Y in a model for sex development, hormone science helped to establish and reinforce the notion of the *sex* chromosome. In 1916-17, embryologist Frank R. Lillie proposed that hormonal factors play a unique role in the fetal stage of sex development. Lillie's work on freemartins (cows that are genetically female with XX chromosomes, but morphologically male) established

with decisive evidence that chromosomes and genes play a partial but not a determining role in sex development (Lillie 1917a). Moreover, for Lillie, particular sex hormones governed the development of primary and secondary sex characteristics. His work on freemartins established that there is a key difference between primary chromosomal sex determination and secondary hormonal sex differences.

Lillie drew a distinction between *sex-determination*, which he thought to be genetic and established at the zygotic stage, and *sex-differentiation* which he believed to be phenotypical and to develop over time (1917b, 464-465). On his view, sex-determination was *genetically* fixed but differentiation was malleable due to hormonal influences acting on development. He was interested in ascertaining just how malleable differentiation is—including up to what point sex-differentiation is reversible. Lillie proposed a two-tier model of sex development: genes function as initiators while hormones operate as the dominant agents in sex-differentiation. In so doing, Lillie offered a new scientific paradigm for the biology of sex.

On this new hormonal, biochemical model the chromosomes ceased to be considered the sole sex-determinants; instead, it was postulated that sex development is a two-step process where the hormones play a distinctive and essential causal role in the development of sex morphology, particularly "after birth" (Lillie 1917b, 465). The two-step model displaced considerable worries over the tenability of the chromosomes as sex determinants given the pliability of sex dimorphism. Due to the fact that Lillie was interested in whether sex development could be reversed in mammals, he studied freemartins, viz., intersex cows, as a means to reach a conclusion. Freemartins typically display properties such as non-functioning ovaries, chimeric XX/XY chromosome patterns, testes, and male-typical behaviours. In the case of freemartins, Lillie concluded that hormones from a male (XY) zygote twin sibling can act on a

female (XX) zygote twin in utero, which can alter the developmental trajectory of the female zygote in utero *and* after birth such that the individual goes on to develop gonads that have the external appearance of ovaries, but also have a fairly advanced internal medullary cord structure associated with male development. In some cases, testes develop under the skin in the groin region (Lillie 1917b, 468).

Lillie concluded that although sex may not be completely reversible from the genetically female zygote to a "normal male" state, he argued that from studying freemartins he could observe that sex is not completely fixed:

> The various cases can be arranged in a series of increasing male-likeness, but the transformation of the female zygote owing to action of the male sex-hormones does not in the case of the free-martin, in the material at our command, proceed all the way to the normal male condition. It is perhaps worth noting that, if it ever did, we would be unable to detect it, except on a basis of much larger statistics than we possess. But the rarity of the more extreme detectable cases makes it seem very improbable that other cases jump all the way across the gap to the normal male. It follows from the data that the female zygote must contain factors for both sexes; the primary determination of the female sex must there-fore be due to dominance of the female factors over the male. If we think of this as a simple quantitative relation, as Goldschmidt (1916) has done, we can explain the intersexual condition of the free-martin as due to an acceleration or intensification of the male factors of the female zygote by the male hormones. The degree of the effect which is quite variable, as we have seen, would of course be subject to all quantitative variations of the hormone…We can, however, state, confidently on the basis of the present results that sex-determination in mammals is not irreversible predestination, and that with known methods and principles of physiology we can investigate the possible range of reversibility (Lillie 1917b, 468-470).

Through his studies of freemartins, Lillie discovered that, barring chromosome structure, sex development is a *flexible* process. Sex permits degrees of variation due to hormonal influences acting as a primary cause of sex development. As a consequence of Lillie's conclusions about the primacy of hormones in sex development, his hormonal focus (seemingly inadvertently) lent scientific legitimacy to the chromosomal account of sex by cementing it within the two-step process of sex determination and differentiation as a parallel mechanism. Once the hormone

model integrated chromosomal sex as the initial mechanism that instigates hormonal processes, the new model amplified the relationship between the X and the Y chromosomes in the biology of sex. The hormonal model reinforced the notion of the sex chromosome in ways that the concept of chromosomal SEX had not previously been afforded. On the hormonal model, although the chromosomal concept does not do much work on its own in development, the hormonal SEX concept depends on the chromosomal SEX concept as a catalyst.

Thus, Lillie's hormonal model served as a new paradigm within the biology of sex, grounding the chromosomal concept as the basis for hormone activation and function. On his view, genes and hormones work together to determine sex development—rather than genes alone—but hormones are particularly influential. In other words, the hormonal model of sex comprises joint endocrinological (hormonal processes) and genetic components, which specify the complex interactions between genes and hormones, which Lillie dubbed chromosomal and hormonal 'sex factors' (1917b). His hormonal model entailed a broader explanatory framework than chromosomal models, and given this broader framework, could more fully capture the dynamic interactions between genes and hormones in sex development. Both genes and hormones act in concert to direct dimorphic sex development. For Lillie, in humans sex is not fully determined by the zygotic stage; rather, genes and hormones act to inhibit or exhibit the development of "maleness" or "femaleness." Moreover, on Lillie's model of sex development in humans, genes carry *intentions* such that the intentions of the genes are necessarily expressed by hormones in the gonads. Lillie's model does not propose that genes alone determine sex, but his model does assume that genes carry information that can be carried out through the actions of hormones. I'll return to the notion of genetic information and its problems for a viable model of sex development below.

In addition to Lillie's work on the biology of sex in the early twentieth-century, geneticists Thomas Hunt Morgan and Richard Goldschmidt both endorsed a hormonal model of sex which held that hormonal and genetic factors play a coequal role in sex determination and development. On Morgan's view, "genetic and hormonal factors act both independently and together to produce the range of secondary sex characters typical to a species" such that both kinds of factors ought to be deemed to explain sex development yet no single theory of sex development can be said to explain all secondary sex characteristics (Morgan 1919, 62). Goldschmidt held an interactionist view of the dynamics between genes and hormones such that he believed genes activate in response to physiological limitations; he called his view *physiological genetics*. Physiological genetics is the study of the interplay between the mechanisms of gene action and developmental mechanisms. Goldschmidt saw the hormonal model as the perfect fit for representing the mechanisms of physiological genetics. Moreover, through his investigation of intersex cases, Goldschmidt aimed to demonstrate that gradations of "maleness" or "femaleness" would result through "manipulating the timing of exposure to sex factors" (Goldschmidt 1926). For Goldschmidt, "sex factors" were "substances" that differentiated the sexes through complex regulatory signalling processes that functioned in a time sensitive manner throughout development.

Lillie, Morgan, and Goldschmidt all concluded that both genes and hormones play important, interactive roles in development and due to this dynamicity, sex development was considered a complex process and sex determination a fluid phenomenon. The idea of sex determination on the hormonal model did not entail that sex is a fixed essence even though the hormonal model appeals to the notion of chromosomal sex and the idea of genetic information.

The fluidity of sex determination on the hormonal model, however, was abandoned after the 1920s, when the idea that gene action, as a determinant of sex, came to the fore.

4. Genetic Information and Sex Determination: The Chromosomal Model

In order to better understand the role of genes in development, particularly sex development, it is useful to explicate what genes are and what they do. Genetics is the study of the diversity, replication, mutation, and translation of information in the genes. The collection of all the genes in an organism is the organism's genome (Lewontin et al. 2008, 786). There are two ways of theorizing genes—in terms of classical Mendelian genetics and molecular genetics. Genes are commonly defined as the fundamental units of heredity in classical genetics. These basic physical and functional units of heredity are deemed to carry information from one generation to the next. We can think of classical genes as being connected to a phenotypic effect such as height, eye colour, or ovarian cancer. The phenotypic effects of classical genes also depend on environmental influences. Furthermore, the classical GENE concept is important to explaining evolutionary change. On the other hand, the molecular gene is important to explaining development. The molecular gene is a DNA sequence that codes for a protein, rather than a phenotype, i.e., it specifies the order of amino acids in a polypeptide chain. In subsections 2.2a-d, I'll discuss the role of genes in relation to classical and molecular genetics in order to provide some context for the later discussion of the contemporary notion of genetic information as it pertains to sex development.

5. Mendelian and Classical Genetics

In 1909, botanist Wilhelm Johannsen coined the term "gene" while studying Gregor Mendel's work from forty years prior. Mendelian genetics is so-called because of Mendel's published experiments in the mid-1860s on inheritance in garden peas, *Pisum sativum,* and its

influence on Johannsen and other scientists in the early 20th Century (Griffiths and Stotz 2013, 10; Lewontin et al. 2008). When Mendel experimented with cross-pollinating pea plants, he discovered what are now referred to as Mendelian ratios, i.e., by mixing crosses (deliberately mating two parental types) he found that the inheritance of a trait is determined by "factors" (what Johannsen later called "genes") that are passed on to offspring. Individual organisms inherit one factor from each parent for each trait, but a trait may not be shown or expressed although it may be passed on to the next generation (Stotz 2006a).

For Johannsen and others, Mendel's research had crucial implications—it uncovered the basic principles of heredity. What Mendel's work contributed to the study of heredity in the early twentieth-century was that it demonstrated that inherited traits (like the colour of flowers or height) between parental organisms and their offspring were transmitted through the genes. For example, on the Mendelian picture, the pea plant does not literally inherit purple flowers from its parents; rather, the plant develops from a seed and while the seed itself does not possess the colour of the flowers, the seed possesses something which impacts the later growth of the plant, as well as the colour of its flowers (Griffiths and Stotz 2013, 13). Mendel referred to this 'something' as "elementen," which is now called the genotype.

In 1911, Johannsen introduced the terms "genotype" and "phenotype" to better characterize this process. Simply put, an organism inherits only its genotype from its parents not its phenotypes. The genotype is the genetic makeup of the organism, whereas from the Greek, phenotype literally means "the form that is shown," i.e., the observable properties of an organism that result from genetic and environmental influences.

The genotypes of plants and animals depend only on their gametes, which merge to form a zygote, on the Mendelian picture:

> Each gene comes in a number of alternative forms, known as 'alleles'. An organism contains a number of loci (places), one for each gene. Each locus can hold two alleles of that gene. An organism's genotype at a single locus is this pair of alleles. These may be two copies of the same allele (the organism is 'homozygous' AA or aa), or one copy of each of two different alleles ('heterozygous' Aa or aA). An organism's overall genotype is the combination of all the pairs of alleles at all the loci (Griffiths and Stotz 2013, 14).

For Mendelians, the genes play a distinctive role in inheritance insofar as while they are not observable entities like phenotypes they serve as tools for predicting expected phenotypes. The phenotype is an observable character that develops later in life—such as the colour of a plant's flowers or its height. A character like height can be influenced not just by its genotype, but also environmental conditions. A plant that has tall parents may grow to roughly the same height as its parents if its growth conditions are similar to its parents—for instance, if the parents grew in a wet year but the offspring's environment is dry, then the offspring may be considerably shorter. Regardless of how the phenotype is expressed, what the organism inherited from its parents is its genotype. For Johannsen, unlocking the process of heredity resided in the genes. The phenotype only offers evidence or signals that one can use to investigate the real phenomenon of heredity—the relationship between the parental genotype and the genotypes of future generations (Johannsen 1911). On this view, the relationships between parental and offspring phenotypes are inherited, but importantly, their expression also depends on environmental factors. The Mendelian genetics research program discovered the basic mechanisms of heredity, and stipulated that the relationships between parental and offspring phenotypes are "mediated" by relationships between genotypes. An important point to take away here is that the study of classical genetics had merits beyond providing highly generalizable basic principles about genotypes. The distinction that Johannsen drew between genotype and phenotype (and his emphasis that phenotypes are not directly inherited characters) was essential to understanding

inheritance and to understanding interactions between an organism and its environment and phenotypic change that factor into evolutionary adaptations.

In short, genetics distinguishes between the genotypes and phenotypes of an individual organism. A genotype is an individual's set of genes and the phenotype is the set of observable traits of an individual. The phenotype develops due to interactions of genes with cellular and environmental factors. Only the genotype is directly and materially transmitted between generations of organisms; the relationship between genes and phenotypic traits is *many-many* insofar as one gene may affect several traits while a single trait can develop based on the action of genes. Unlike classical genetics, early Mendelian genetics did not consistently differentiate between genotypes and phenotypes. For classical genetics, a gene occupies a particular point on a chromosome called a locus, which may house different genes in different individual organisms. Moreover, the idea of a gene is the same as that of an allele, and alleles are best understood as difference-makers in classical genetics. A gene occupies a particular place on a chromosome, which is called a locus, and a locus may hold different genes on different individuals. A particular trait, like orange fur on a ginger cat, may be brought about by the action of different alleles at multiple loci, each of which is required for the phenotype of orange fur. However, if only one of these alleles at a particular locus is mutated (the locus is occupied by a different allele) then a different (mutant) phenotype will be produced. Given a particular total genetic and environmental background, if a particular allele is at a locus, this can result in orange fur, whereas the presence of another allele at the same locus would result in fur of a different colour. Although a trait can be influenced by many genes, a genetic difference at a certain locus can result in a phenotypic difference. Classical genes are identified by way of the phenotypic

differences they produce, which can be seen in mutation studies where individuals with differing phenotypes are crossed (Brigandt 2006).

6. Classical Genetics and the Sex Chromosome

The concept of the sex chromosome in classical genetics was not widely accepted amongst researchers in the early twentieth-century. Firstly, in the advent of chromosome research, chromosomes were named and classified simply in terms of pairing behaviour in the course of meiosis (a type of cell division that reduces the number of chromosomes by half), and according to their morphology. The term 'sex chromosome' contravened standard classification in classical genetics, which focused on *traits linked* to chromosomes rather than specifying particular chromosomes. Secondly, researchers were concerned that the use of the sex chromosome term and concept was reductive and deterministic as it did not capture the complex relationships between chromosomes, traits, and sex. Geneticists Theodore Boveri and Walter Sutton demonstrated that chromosomes were the carriers of genetic material. Boveri (1902) developed the notion of chromosomal individuality, i.e., chromosomes had specialized functions and transmitted genetic factors for biological traits. Sutton (1902), meanwhile, believed that chromosomes carried Mendelian alleles and connected the meiotic division and recombination of chromosomes to hereditary factors (14). Despite the focus on the relationship between chromosomes and biological traits amongst some geneticists, Mendelian genetics also came to be associated with the X and Y chromosomes as binary sex chromosomes.

Although critics of sex chromosome terminology attacked the notion of the sex chromosome for being overly simplistic, for its inability to explain sex across species, and for failing to have a mechanism to explain its role in determining sex, the terminology withstood these criticisms (Richardson 2013, 57). Sex chromosome terminology withstood these criticisms despite it being

the case that, although the X was considered a "sex factor," most examples of X-linked inheritance were for traits that are *not* sex characteristics. For example, studies conducted by Morgan's team of researchers on *red eyes* in the fruit fly *Drosophila melanogaster* found that the allele for red eyes is linked to the X chromosome. Moreover, Morgan and Lillian Vaughan Morgan discovered the first sex-linked genetic mutation, *white eyes* in *Drosophila*, which led to the discovery of *sex-linkage*: where a gene for a trait is found on a sex chromosome (Brigandt 2006). These genetic findings in *Drosophila* show that traits on the so-called sex chromosomes are not limited to sex characteristics; in fact, much of the Morgan school research showed that many traits on the putative sex chromosomes are not sex characteristics and play no role in sex development.

During the height of Mendelian genetics (until the 1910s), one view was that hereditary material is not contained inside a cell's nucleus (comprising the chromosomes), but that resides within the cytoplasm. In light of this, it is important to note that on the chromosome theory of inheritance, hereditary material is a physical part of chromosomes, and this account was established via the Morgan team's research on *Drosophila*. *Drosophila* was the central model organism for classical genetics and the discovery of sex-linked inheritance was a key evidence in favour of the chromosome theory of inheritance, which then surpassed traditional Mendelian inheritance. With the explanatory power of the chromosomal theory of heredity came the use of sex chromosome terminology despite critics who thought the terminology was reductive. The use of the term 'sex chromosome' became more widespread throughout the 1920s and 1930s such that it became synonymous with the X and Y chromosomes, and the alternative labels—*accessory chromosome* and *heterochromosome* fell to the wayside. The term 'sex chromosome' became the standard term used as a matter of convenience, but also in part due to Sutton's

research identifying the X and Y chromosomes, particularly the X—which he identified with maleness, as carriers of heredity (Sutton 1902, 37-38). A crucial point, however, is that although the sex chromosome terminology became standard amongst geneticists in the 1930s, a sex chromosome concept that held that sex was determined by the sex chromosomes was widely rejected. In other words, although 'sex chromosome' became shorthand for the X and Y, few geneticists believed that the X chromosome determined sex. A more complicated concept of SEX, that favoured *linked* biological traits, rather than *determined* ones, was still in use. The X and Y chromosomes served a key role in establishing the case for the new chromosomal theory of heredity.

Although Morgan came to accept the new sex chromosome terminology, he held that the X was a sex chromosome because it carried at least one important hereditary factor *linked* to sex—not because it *determined* sex (Morgan 1914). The study of sex-linkage, particularly by *Drosophila* researchers, became the primary way in which geneticists studied mutations. The simplicity of sex chromosome terminology became critical to genetics research in drawing attention to the Mendelian theory of heredity and to the sex-linkage research program that demonstrated the chromosomal basis of Mendelian traits (Morgan and Bridges 1916). Even though terms such as 'accessory chromosome' or 'heterochromosome' that were, arguably, more descriptively accurate in terms of characterizing the structure and behaviour of the X and Y chromosomes, the simplicity of sex chromosome terminology won out. In sum, the sex chromosome concept in classical genetics largely concerned the relationship between chromosomes and biological traits that were associated with sex—e.g., where the X chromosome carried traits that were thought to be reliably sex linked. With the study of molecular genetics, however, the sex chromosome concept shifted from one of sex-linkage to one of sex determinacy.

7. Molecular Genetics

It is important to explore the differences between classical and molecular genetics to better understand the role that genes play in the chromosomal understanding of sex. The classical gene has been treated as an instrumental tool in areas such as quantitative behavioural genetics and developmental science where, in the former's case, Mendelian alleles are invoked to track phenotypes, and in the latter's case, abstract developmental genes play an explanatory role in developmental research models (Stotz 2006a, 2006b). The use of the term 'gene' continues to vary across subfields in biology, and different biologists offer different characterizations of what genes are and do. Depending on the research context, scientists may emphasize various aspects of genes.

Molecular genetics seeks to associate specific traits with specific alleles or with allele combinations (Longino 2013, Tabery 2009, Laubichler and Wagner 2001). The 1950s and 1960s saw a turn to molecular genetics, given the discovery of the structure of DNA by James Watson, Francis Crick, and Rosalind Franklin. On the molecular conception of the gene, no single DNA segment is tied to a gross phenotypic effect. Rather, molecular genetics focuses on molecular traits where, on its simplest rendering, a molecular gene codes for a single polypeptide. Molecular genetics is concerned with how molecular genes function in biochemical and molecular mechanisms within cells, rather than classical genetics which for the most part examines inheritance.

The discovery of the structure of DNA provided a material basis for the gene: the DNA molecule, and although classical genetics were primarily defined on a functional basis, i.e., in terms of their phenotypic effects, molecular genes were defined in terms of their intrinsic

structure (their DNA sequence). The discovery of DNA turned Mendel's genes into entities with a molecular structure. Paul Griffiths and Karola Stotz (2013) argue that:

> Although the new, molecular identity of the gene has no dominant identity, the old instrumental identity did not simply go away. The original role of the Mendelian gene continues to define the gene in certain areas of biological research: namely, those intellectually continuous with classical genetic analysis… The Mendelian gene turned out to be grounded in DNA, but the development of genetics has left us with more than one scientifically productive way of thinking about DNA and the genes it contains (33).

Considering scientific advances in the mid-twentieth-century, particularly advances in the study of genetics with the use of more powerful microscopes, X-ray diffraction, and innovative imaging methods, the gene as a hypothetical physical unit became the material gene. This change, however, did not come about due to a rejection of Mendelianism in the spirit of Goldschmidt's criticisms. It was not the case that the Mendelian gene was rejected or purported not to exist, after all, doing so would entail a rejection of the data that experiments in classical genetics generated. Such data proved to be useful in going forward with genetic analysis throughout the first half of the twentieth-century (Griffiths and Stotz 2013, 26).

Molecular genetics did not supersede classical genetics. What happened instead was that the instrumental (i.e., classical) concept of the GENE helped shed light on the nature of the material (i.e., molecular) concept of the GENE given technological and experimental advances and applications (Stotz 2006a, 2006b). The material gene had been a concept all along in classical genetics, but it was a hypothetical one without a known internal material basis. Even though classical genetics did not itself reveal the molecular structure of the gene, advances in genetic analysis helped spur the discovery. Genetic analysis provided the grounds for the theory of a gene as a material unit of heredity, and scientists were still working within a framework of genetic analysis provided by the classical paradigm when the DNA-helix was discovered.

Although it is the case that some geneticists wanted more from a concept of the GENE that was purely instrumental and hypothetical (such as Goldschmidt), classical genetics was able to solve puzzles of heredity without scientists knowing the nature of the material structure of the gene. Furthermore, even though molecular genetics has provided the Mendelian gene with a material basis, molecular genetics has not rendered the Mendelian gene obsolete, insofar as the classical gene is still important to considerations of evolutionary change. The molecular gene cannot serve the same role in explaining evolutionary change, viz., related to adaptive change, that the classical GENE concept can. Put briefly, the molecular gene taken as a DNA segment does not produce phenotypic effects on its own, and the same phenotypic effect can be realized by various molecular clustering.

Griffiths and Stotz (2013) argue that after the discovery of the double helix, it was not until 1958, with the publication of Crick's "Central Dogma," that the notion of genetic information really gained traction in biological discourse (39-40). Crick's "Central Dogma" introduces the notion of Crick information:

> This states that once 'information' has passed into protein *it cannot get out again.* In more detail, the transfer of information from nucleic acid to protein may be possible, but transfer from protein to protein, or from protein to nucleic acid is impossible. Information means here the precise determination of sequence, either of bases in the nucleic acid or amino-acid residues in the protein (qtd in Griffiths and Stotz 2013, 40; Tabery et al. 2015, italics used in the original).

According to James Tabery, Monika Piotrowska, and Lindley Darden, Crick's "Central Dogma" describes the concept of *genetic information* as the linear sequence of codons (i.e., DNA triplets each of which encodes a single amino acid) on the DNA molecule that are "transcribed to messenger RNA, which are translated to linearly order the amino acids in a protein" (Tabery et al. 2015; Lewontin et al., 2008 782). In other words, the linear sequences of nucleotides (which are

molecules consisting of a nitrogen base, a sugar, and a phosphate) in a DNA segment specifies the sequences of nucleotides in the RNA and the RNA molecule specifies the sequences of amino acids in a protein through the genetic code (Stotz 2006a, 2006b ; Lewontin et al., 2008, 792). Or speaking metaphorically, on Crick information, the DNA serve as the shed which stores genetic information and the RNA serves as the bridge which transfers it from the cell nucleus to the cytoplasm for protein-building.

Crick conceived of this process as a process that specifies information, and Fox Keller notes that Crick's crude paraphrase of his "Central Dogma" is: "DNA makes RNA, RNA makes protein, and protein makes us" (Stotz 2006b). To put it simply, the point here is that on Crick's conception of information, genes carry information to make proteins, which are deemed as the building blocks of life. Tabery et al. note that:

> The language of information is used ubiquitously by molecular biologists. Genes as linear DNA sequences of bases are said to carry "information" for the production of proteins. During protein synthesis, the information is "transcribed" from DNA to messenger RNA and then "translated" from RNA to protein. With respect to inheritance, it is often said that what is passed from one generation to the next is the "information" in the genes, namely the linear ordering of bases along complementary DNA strands. Historians of biology have tracked the entrenchment of information-talk in molecular biology (Kay 2000) since its introduction (2015).

The notion of information in molecular biology, however, became more complicated than the notion articulated in 1958 in Crick's "Central Dogma." Only a year later, geneticists François Jacob and Jacques Monod introduced a distinction between regulatory and structural genes, which added another layer of complication to thinking about information in genetics (Fox Keller 2000, 55). They engaged in studies on bacterial enzyme induction (originally called adaptation) where a bacterium produces enzymes in response to environmental conditions (e.g., where a bacterium synthesizes an enzyme that's required to metabolize an energy source only if this

energy source is present in the environment; this process involves the activation of some structural genes).

Historian and philosopher of science Evelyn Fox Keller notes that Jacob and Monod's studies on enzyme induction found that in order to have a proper conception of the biosynthesis of proteins (the process in which cells build proteins), one must assume that chromosomes "house" more than one kind of gene, i.e., not only genes that code for the proteins needed to make an organism, or *structural* genes, but a proper conception of the biosynthesis of proteins calls for *regulatory* genes as well, i.e., genes that regulate the frequency at which such structures are transcribed (Fox Keller 2000, 55). So, on their picture, we have two kinds of genes that contribute to protein biosynthesis, which enriched Crick's notion of information where one gene makes one protein.

Furthermore according to Jacob and Monod, the regulator gene is a "hereditary determinate which, when active, controls the rate of transcription or certain specific structures in genes without itself contributing any structural information to the proteins" (Fox Keller 2000, 56). On their view, genes are the kind of things that do not merely act; rather, they must be activated in order to fulfil their role in genetic processes. Thus, on their account, there are some genes that govern other genes—structural genes specify which proteins are built and regulator genes oversee that the structural genes are fulfilling their role. One kind of gene codes needed to make an organism, while the other kind of gene supervises (and initiates the work of the former). For Jacob and Monod, gene action was two-fold: regulatory genes activate (or inactivate) structural genes. The structural genes carry information for building proteins.

Jacob and Monod's theory of how genetic information is transcribed for protein building, however, also saw complications. In the late 1970s, Richard Roberts and Phillip Sharp

discovered split genes in high organisms, which made Monod's quip that, "whatever is true for the bacteria E. coli will be true for the elephant," quite untrue (Griffiths and Stotz, 51). Suffice to say that the discovery of split genes (i.e., genes that are fragmented such that their coding segments of DNA, exons, are intermixed with lengthy noncoding regions, called introns or "junk DNA") undermined the notion that there is a one-to-one relation between gene sequence and the protein it builds (Fox Keller 2000, 59-60). Where Monod assumed that there is a one-to-one relation between structural DNA units on an open reading frame (i.e., a piece of DNA that begins with a start codon and ends with a stop codon) and gene products it turned out to be the case that the structural basis of gene function is much more complicated; more than one kind of reading frame can give rise to gene products. Thus, the relationship between genetic elements and gene products (RNA molecules and polypeptides) is many-many.

It is not just structural genes on a continuous sequence that build protein. Rather, with alternative splicing one sequence of mRNA can build many proteins (one-many relation), and with transplicing many pre-mRNA molecules can give rise to one mature mRNA molecule. Pre (1) and mature (2) mRNA molecules are respectively (1) incompletely processed mRNA molecules in eukaryotes and (2) mRNA molecules that are fully processed and ready to be exported from the nucleus and translated into the cytoplasm in eukaryotic cells. Eukaryotes are organisms (e.g., plants, animals, fungi) that have eukaryotic cells (single or multicellular organisms that have a membrane bound nucleus) (Lewontin et al., 2008, 785).

So, there is a one-to-one relation between DNA and pre-mRNA, but a many-many relation between pre-mRNA and mature mRNA and protein. How do split genes build proteins without having a continuous sequence? According to Fox Keller: "a number of special protein/RNA complexes (called *spliceosomes*) prepare the primary transcript for protein

synthesis by excising introns. The remaining exons are then spliced together to form a continuously coding (mature) transcript" (60). She notes, however, that exons can be spliced in more than one way and that depending on the context, many pieces of RNA transcript can be put together to form many sequences templates that yield to the construction of a variety of proteins (Fox Keller 2000, 60-61). When we consider the impact that split genes have had on understanding the notion of genetic information, a significant lesson that we can take away is that there are many varieties of protein that can be built with one gene, and that a protein can have many functions in the cell (that is, proteins can be susceptible to cellular regulation) (Fox Keller 2000, 64-66).

The upshot here is that there is no simple, one-one relationship between genes and the proteins they build, which makes articulating a notion of genetic information where what genes do is to provide information for building proteins (or organisms) more complicated. On Jacques and Monod's view, gene function boils down to regulation and providing structural guidance, but as we can see, "giving structural guidance" can be multiply realized, and protein building or organismal development does not simply hinge on the function of the structural gene with a continuous coding sequence. Gene splicing shows us that DNA structure can be broken. With RNA editing, transcribed mRNA can be modified (i.e., edited) by cellular proteins and subsequently translated such that the sequence of the edited RNA no longer completely corresponds to the gene (DNA sequence) (Stotz 2006a, 2006b). Importantly, genes do not have a single identity nor do they have a single function—not on the Mendelian picture nor on the molecular picture. The notion of genetic information assumes that genes carry information in a "bottom-up" fashion and that this function in development is more essential than other functions. This "bottom-up" approach can imply a gene's-eye-view of development, which places emphasis on the role of genes as a central cause of development.

8. Molecular Genetics, Sex Chromosomes and Determination Relations

As mentioned in Section 2, hormone research cemented the concept of chromosomal sex in the mid-twentieth-century beyond the concept of sex-linkage popular in the early twentieth-century. In 1959, it was discovered that the Y chromosome carries important genetic factors in male sex development, which upended the long-established consensus that the X chromosome played the central role in sex development (Richardson 2013, 77). *Drosophila* research in the early twentieth-century led geneticists to believe that sex depended on the presence and number of X chromosomes rather than the Y given that chromosomal patterns such as XO males and XXY females were discovered. Findings from *Drosophila* chromosome research were extrapolated to assumptions about human chromosomal makeup, which held that the Y chromosome held no role in sex development. Geneticist William Castle was one of the first to maintain that the Y chromosome played a unique role in male sex determination (Richardson 2013, 72).

The focus on the Y chromosome as being the chromosome for 'maleness' carried into the 1980s and beyond due to the popularity of the XYY supermale studies in humans in the 1960s and 1970s. In the 1960s, geneticist Patricia Jacobs postulated that an additional Y chromosome led to unusually aggressive behaviour in males (Richardson 2013, 84). In 1965, Jacobs and her research team published the most famous paper on the subject, "Aggressive Behavior, Mental Sub-Normality and the XYY Male." In the paper, they hypothesized:

> …an extra Y chromosome predisposes its carrier to unusually aggressive behaviour. We decided that if this were the case, then we might expect an increased frequency of XYY males among those of a violent nature. The purpose of this communication is to report our findings in a survey of mentally sub-normal male patients with dangerous, violent or criminal propensities in an institution where they are treated under conditions of special security (Jacobs et al. 1965, 1351).

They concluded that of the "abnormal patients"" (XYY men) studied, they were unusually tall, but the research team was unclear as to whether the increased frequency of XYY males found amongst inmates in the psychiatric institution they visited was related to "the men's aggressive behavior or to their mental deficiency or to a combination of those factors" (Jacobs et al. 1965, 1352). XYY researchers postulated that the Y chromosome was the key to male and masculine development, and for years geneticists argued over the alleged social dangers of individuals with XYY.

The XYY studies were later shown to be informed by biased assumptions about male violence and aggression, and were revealed to be empirically inadequate—e.g., researchers used small sample sizes, drew only on research subjects who were incarcerated in high security institutions, did not use double-blind protocols, ignored environmental variables, and lacked a well-defined mechanism (Richardson 2013, 87). Moreover, XYY researchers assumed at the outset that an additional Y chromosome would cause violent and aggressive behaviour due to having the additional Y chromosome, instead of assuming that there would be more generally impairing effects simply due to having an extra chromosome (Richardson 2013, 87). Although the XYY studies were later abandoned and deemed to be scientifically flawed, the molecular chromosomal sex concept was cemented during the 1960s-70s and the idea that maleness, masculinity, and the Y chromosome are all a part of a determination relation. Richardson (2013) notes that according to the PubMed research database, "by 1970, nearly two hundred papers on the link between XYY and aggression had appeared in the scientific literature. Between 1960 and 1970, XYY research comprised 82 percent of all published scientific studies on the human Y chromosome" (84). Furthermore, Richardson found that from 1960 to 1985, 28 percent of all genetic research on the Y chromosome was XYY research. The XYY studies

solidified the molecular chromosomal SEX concept and after the era of "supermale" research, the Y chromosome came to be an integral part of the *molecular* chromosomal SEX concept, which holds that the genetic material carried on the X and Y chromosomes determine an individual's sex and gendered behaviour.

It would not be until 1990 that the SRY gene on the Y chromosome would be discovered and deemed the "testis-determining factor" (Berta et al. 1990). With the rise of molecular genetics in the second half of the twentieth century, the chromosomal SEX concept developed into something stronger than Lillie's sense of genetic sex—where sex is said to be "determined" at the genetic level, but "differentiated" later in development, viz., at the gonadal, genital, and morphological levels due to hormonal influences. Instead, the idea of chromosomal sex shifted from Lillie's more limited notion of fixed genetic sex to a notion of determination where XX or XY chromosomes *cause* sex-differentiation. For Lillie, sex determination (XX or XY patterns) and differentiation come apart, and in a sense, are two distinct properties, especially given that Lillie believed that freemartins were initially genetic females, but went on to have an intersex differentiation. Lillie's sex determination and sex-differentiation are distinct because they have distinct causal powers—i.e., although genes on the XX or XY chromosomes may trigger the development of one type of embryonic gonad over another, the hormones that those gonads produce have their own causal powers.

On the chromosomal model, however, determination and differentiation do not come apart in the same way. We can see this element at work in Simon Baron-Cohen's (2003) claims about sex differences in the brain and in the genetic makeup of humans and other mammals as well as in geneticists Francisco J. Sánchez and Eric Vilain's (2010) remarks that sex-determining genes initiate a series of events that determine an organism's sex and lead to the differentiation of the

body in sex-specific ways (Baron-Cohen 2003, 114, Sánchez and Vilain 2010, 65). Baron-Cohen (2003) claims that genetic sex means that "you are male if you have one X and one Y chromosomes (XY), and you are female if you have two X chromosomes" (97). He then goes on to argue, "Your genetic sex is set at the point of conception, and is straightforward to determine. Most people who want to determine whether a person is male or female stop at this first level" (98). Although Baron-Cohen has the view that an individual can have "mixed" female/male properties, e.g., one can be genetically male but engage in "female sex-typical behavior," he also argues that genes play a special role in sex development:

> We have considered sex differences in the brain, but the other big source of variation between the sexes is the genes. We know that some genes are sex-linked and this may be a major determinant of the male and female brain types. Furthermore, genetic and hormonal effects need not be mutually exclusive. Genes may affect testosterone secretion, for example. There are genes on both the sex chromosomes (X and Y) and on some of the other chromosomes that can affect sex-typical brain development and behavior. These have been studied in the rodent, but an important human medical condition, Turner's Syndrome, has also highlighted the role of the X chromosome in producing sex differences in human behavior (114).

Baron-Cohen holds that genetic sex plays a primary causal role in sex development, the full extent of which, he claims, is still uncertain. He argues, however, that we can be confident that researchers will someday know which genes control sex-typical behaviour, which he identifies as sympathizing versus empathizing behaviours[31] (114). Baron-Cohen identifies sex development as having a major "bottom-up" component. Another researcher, David C. Page, a geneticist at

[31] According to Baron-Cohen, males develop systematizing brains whereas females develop empathizing brains. These two brain types lead individuals to engage in and excel at systematizing or empathizing behaviour. Systematizing behaviour involves a proficiency in mathematical and logical reasoning and organizational skills. Empathizing behaviour involves proficiency in communication and "mind-reading" (2003, 29-84). I'll further consider systematizing and empathizing behaviour as types of brain sex in Section 3 of this Chapter and in Chapter III of the dissertation.

MIT views genes on the sex chromosomes as being a central determinant of sex. Most notably, his research on the Y chromosome champions the SRY gene as "building" males:

> … you [Curt Stern] also speculated that the human Y chromosome might have a role in sex determination, as was known in guppies and gypsy moths. You were right! In the developing human embryo, the gonad is the first structure to differentiate, anatomically, between XX and XY. Through work that began with Charles Ford (Ford et al. 1959) and Patricia Jacobs (Jacobs et al. 1959) and culminated in the laboratories of Peter Goodfellow and Robin Lovell-Badge, we now know that a single gene on the Y chromosome—SRY—instructs the gonads to develop as testes (Sinclair et al. 1990; Koopman et al. 1991). Built around this knowledge is much additional genetic insight into the making of testes—and males. But here's the rub. Embarrassingly, in the year 2003, we know little genetically about the making of the ovary, about how an XX embryo begins to become a phenotypic female. We shamelessly legitimize our ignorance by referring to the female pathway as the "default." And so I pose a question for the future: what is the role of genes in the making of the ovary? I would like to offer an early observation that pertains to this question. Curt, we now think of genes not only as sites of heritable variation underlying phenotypes but also, through their RNA or protein products, as markers of cellular identity during development. My colleague Douglas Menke identified a gene, Stra8, whose expression pattern in embryonic gonads is intriguing in this light… Stra8 is expressed in XX (but not XY) embryonic gonads, in a slowly advancing wave that begins at ~E12.5, near the anterior pole of the embryonic ovary, and ends at ~E16.5, near the posterior pole. Other experiments have shown that Stra8 is expressed only in germ cells, not in the somatic cells of the gonad. At present, Stra8 expression in germ cells is the earliest known marker of female differentiation in mammals (Menke et al. 2003). These findings raise the possibility that the first steps in turning an XX embryo into a phenotypic female may unfold in germ cells. Much work remains to be done! (2004)

For Page, the SRY gene plays a determining role in sex development such that it "makes" testes *and* individuals male, and the Stra8 gene on XX chromosomes may play a determining role in female development.[32] Given that Sánchez and Vilain also view genes on sex chromosomes as determinants that lead to sex-specific differentiation in development, and since genes on sex chromosomes play a central role in sex development for Baron-Cohen, particularly for brain sex and behaviour, it may be helpful to consider the direction of causality between genes and

[32] The SRY gene is the 'smoking gun' gene for male development; an analog has not been identified on the X chromosome for female development.

development on their accounts. It may be particularly useful to think of these accounts as a expressing a determinable/determinate relation—where sex is a *determinable* of chromosomal sex, and chromosomal sex is the *determinate*. If we take genes on the sex chromosomes to play a central role in sex development, such as the SRY on the Y chromosome, some traditional features of that determinable/determinate relation may include:

> *Increased specificity*: If XY is a determinate of (determines) being male, then to be XY is to be male, in a specific way.
>
> *Determination 'in respect of' determinables*: If XY determines being male, XY is more specific than being male.
>
> *Determinable inheritance*: For every male with XY, if individual A has XY at a time *t*, then A must be male at *t*.
>
> *Requisite determination*: If A is male at time *t*, then for every level of determination of being male: A must have XY at *t*.
>
> *Determinate incompatibility*: If A has the determinate XY of the determinable being male at *t*, then A cannot have, at *t,* any other determinate at the same level of specificity as XY.
>
> *Unique determination*: If A has a determinable, being male, at a time, then A has a unique—one and only one—determinate, XY, at any given level of specification at *t.*
>
> *Asymmetric modal dependence*: If XY is a determinate of being male, then if A has XY, then A must be male, but for some individual B, B might be male without having XY.
>
> *Causal compatibility*: Determinables and determinates do not causally compete.[33]

Requisite determination and *determinable inheritance* imply *unique determination* such that if XY is a determinate of being male, at a time, let us say birth, then XY is a unique determinate of being male. It is important to note, however, that *unique determination* and *requisite determination* can permit of exceptions. Philosopher Jessica Wilson (2013, 2017) contends that

[33] This is not a complete list of the features of determinable/determinate relations, and as Jessica Wilson (2017) notes, not all of these features may be typical of determination in a strong sense—i.e., as being required in order for the determination relation to hold. Instead, some features may only need to be generally true of some or most instances of the relation or its relata. For a full list of features see section 2.1 of Wilson's entry on "Determinables and Determinates" in the Stanford Encyclopedia of Philosophy.

> … even for a paradigmatic determinable such as color, *Unique determination* is not generally correct, since the case of an iridescent feather is reasonably interpreted as one in which the feather is (a) colored, (b) red from one perspective, and (c) blue from another perspective, such that no one determinate shade is non-arbitrarily identified as "the" unique determinate determining the determinable color had by the feather (2017).

Instead, she argues that the iridescent feather in this case is red or blue relative to perspective (2013, 367-368). In the feather case, multiple perspectives may be in play, and multiple colours instanced, at a time *t*, thus the feather can have determinates that are multiply realized at *t*. Multiple realizability is the notion that the same property, state or event, e.g., being coloured, can be instantiated by a variety of other properties, states, or events, e.g., the colours red, blue or yellow. Wilson's example provides reason for believing that determinates can be multiply realized, and thus for rejecting the supposition of unique determination.

In the case of sex, only a gene's-eye-view would preclude the possibility of multiple determinates at a time. Lillie's determination/differentiation account of sex would reject the idea that genes are *the* unique determinate of sex development. Baron-Cohen views genes as having a central determining role in sex development and he argues that genetic effects and hormonal effects should not be seen as mutually exclusive—genes can affect hormones, which affect sex development. Given Baron-Cohen's claims about the mutual *inclusivity* of genetic and hormonal effects in sex development, it is important to consider further the supposition of *causal compatibility*.

Philosopher Stephen Yablo (1992) argues that determinables and determinates do not causally compete:

> …we know that [determinables and determinates] are not causal rivals. This kind of position is of course familiar from other contexts. Take for example the claim that a space completely filled by one object can contain no other. Then are even the object's *parts* crowded out? No. In this competition wholes and parts are not on opposing teams… (259).

Moreover, Jessica Wilson (1999) contends that "determinables and their determinates, like objects and their parts, are guaranteed to be on the same team because they are internally related" (47). In her 1999 paper, Wilson offers the example of scarlet (a shade of red) and the colour red as falling within a determinable/determinate relation, where scarlet is a determinable of red. She argues:

> A determinable property, like being red, has a variety of causal powers, including say, the power to induce Sophie the pigeon to peck at a decent-sized patch with this property if it is placed in front of her. Now, Sophie will, in the process of pecking at a red patch, also be pecking at a red patch of a particular shade, say scarlet. But even though the patch's being scarlet also has the causal power to cause Sophie to peck at it (since to be scarlet is just to be red, in a particular way), there is no danger of these two properties' inducing any causal overdetermination with respect to Sophie's pecking. And the reason *why* this is so—the reason why 'determinables and their determinates are not causal rivals'—is because it is plausible, in the case of determinables and determinates, that each causal power of the determinable is identical with a causal power of its determinate (47-48).

If Wilson is correct that *causal compatibility* for determinable/determinate relations means that each causal power of the determinable is identical with a causal power of its determinate, and we apply this to the case of sex, then being male and having XY can be said to have the same causal influences. This result fits with Baron-Cohen's view that genes and hormones have inclusive effects in sex development. His account implies that genes act on sex development through triggering, e.g., testosterone secretion, which impacts the brain and behaviour. In other words, genes on sex chromosomes can be said to cause sex development in terms of brain and behavioural development.

Not quite the same can be said for Sánchez and Vilain (2010) who maintain that there are sex-determining genes that cause sex differentiation at the phenotypic level. Sánchez and Vilain hold that while sex chromosomes *determine* sex, sex-determining genes such as SRY, Sox9, and

Wnt-4[34], cause phenotypic females and males in sex development (2010, 67). Something to note, however, concerning Sánchez and Vilain's view is that neither Sox9 nor Wnt-4 are on the X or Y chromosomes, and Wnt-4 is crucial to the development of lungs and the respiratory system, the development of the kidneys, and to muscular development in vertebrates. Of the approximately 1500 genes on the X and 78 genes[35] on the Y chromosomes, the SRY has been the most extensively studied and identified as specifically "sex-determining." The SRY has been identified as the gene on the Y chromosome that acts as a trigger for male development in mammalian embryos. Genes on *other* chromosomes, however, that have been identified to play an important role in sex development are also referred to as "sex-determining."[36] Aside from Wnt-4, other genes important to female sex development are Rspo1 and Foxl2, which aid in ovary differentiation and maintenance, and work with Wnt-4 to supress Sox9 (Eggers and Sinclair 2012). The upshot is that while specific genes are involved in sex development, and more significantly, work together in networks of genes in development, not every gene identified with sex-determination is on a sex chromosome and not every gene on the sex chromosomes is involved in sex-determination. In fact, the gene most prominently identified with sex development is the SRY Y-chromosomal gene, which fits Baron-Cohen's causal picture, but the "female-determining" Wnt-4 gene that Sánchez and Vilain pick out does not exactly fit that causal picture. The reason why is that Baron-Cohen uses the sex nomenclature of sex-

[34] Gene Sox9 is considered central to male sex development. However, it sits on 17q24 in humans. It inhibits the creation of female sex organs, and also interacts with other genes such as FGF9 to develop testis sex cords and Sertoli cells, which are cells of the testicles that aid in sperm production. Gene Wnt-4 sits on chromosome 1 and is constructive in female sex development, the development of an embryo during pregnancy, and in lung, kidney, and muscular development.

[35] Researchers use different approaches to predict the number of genes on each chromosomes, so estimates vary.

[36] Many of the genes on the X chromosome are not linked to sex development. Most of the genes on the Y chromosome are involved in cell maintenance and sperm production, with the SRY gene being involved in the development of testes. The X chromosome carries between 800 to 900 genes that provide instructions for making proteins, which perform a variety of different functions in the body. It is important to note that the X chromosome even plays a crucial role in sperm production (Mueller et al. 2013).

determining genes on the sex chromosomes, which works for SRY, but does not work for the variety of genes identified as "sex-determining" but that are not on the X or Y chromosomes. In order for Sánchez and Vilain's view to have the same determinable/determinate causal picture that Baron-Cohen's view does, the sex nomenclature, or even the concept, would have to be altered such that *genes on chromosomes* trigger sex development, rather than *sex-determining genes on sex chromosomes.* Otherwise, maintaining that sex-determination causes sex-differentiation through sex-determining genes on sex chromosomes only accounts for male sex development, and leaves out a comparable account of female sex development. At the very least, in the style of David C. Page, the lack of a comparable account for female sex development should be highlighted in the research.

Moreover, if the relationship between genes and sex development, as Baron-Cohen, Page, and Sánchez and Vilain describe them, can be characterized as a determinable/determinate relation, the feature of *causal compatibility* renders the causal powers of being or developing a sex the same as the causal powers of sex-determining genes. As I have shown, however, because not every gene identified as influential in sex development is located on a sex chromosome, some "sex-determining" genes have causal powers distinct from female or male sex development, i.e., these genes do other work in the body, and thus have more causal powers. Put differently, the set of causal powers of sex development lacks some of the causal powers of the set of "sex-determining" genes, so the former is a proper subset of the causal powers of the latter. An easier way to highlight the relations at stake here is to think of the causal powers of the colour red as a proper subset of the causal powers of the shade scarlet. Red's powers are a proper subset of scarlet's causal powers because it has fewer properties than scarlet has—viz., red lacks the blue that comprises scarlet. And if a pigeon, unlike Sophie in Wilson's example, were

attracted to pecking only scarlet patches instead of red patches, then the shade scarlet would have more causal powers than the colour red (Wilson 1999, 48). Furthermore, the colour red's powers is a subset of all its determinates' powers (e.g., scarlet, auburn, oxblood), thus has overlapping causal powers with its determinates.

By applying Wilson's example to the case of sex[37]: it turns out that the set of causal powers associated with sex development is a subset of each of the sets associated with the powers of its determinates (e.g., sex-determining genes, sex chromosomes or sex hormones[38]), which indicates that sex development is, like many higher-level properties, multiply realizable (Wilson 1999, 48). Sex's determinates are multiply realizable because no one unique determinate necessarily causes trajectories in sex development (e.g., testes can develop in the absence of the testis-determining factor SRY) because other determinates in sex development have causal powers. Thus, Baron-Cohen's causal inclusion thesis for genetic and hormonal effects is not, in every situation, sufficient for describing determination relations in sex development.

9. Making Sense of the Chromosomal Sex Concept

According to philosopher of science Helen Longino, although "molecular studies can, in principle, identify genes or alleles whose presence in the genome plays a major causal role in the expression of a phenotypic trait," molecular studies are not designed to differentiate between a

[37] Here I use Wilson's (1999) causal powers/proper subset framework to illustrate how sex development is multiply realized. The point is to show that the causal powers involved in sex development are not causally inclusive of genetic factors, i.e., chromosomal sex does not determine sex development—it is only one causal factor and not *the* determinate of sex development. My multiple realizability claim does not hinge on Wilson's example of the causal powers of the colour red, but her example is a helpful conceptual tool.

[38] A hormone is a chemical substance that is produced in the endocrine glands. This substance is carried through the bloodstream to interact with an organ (at some distance from its place of origin) in order to stimulate the organ's function (Fausto-Sterling 2000a, 193). Fausto-Sterling argues we should reject the idea that hormones in the form of androgens and estrogens are *sex* hormones that serve necessary and discrete organizing functions in sex development. She advocates that we switch from conceptualizing androgens and estrogens as sex hormones to conceptualizing them as steroid hormones that play a variety of roles in the human body's organ systems in addition to sex development.

genetic hypothesis and those concerning certain non-genetic factors (2013, 59; Robert 2004). For instance, a molecular study cannot differentiate between a hypothesis concerning genes on the X and Y chromosomes and a hypothesis about sex at higher levels of organization such as gender psychology. Molecular studies can shed light on genetic hypotheses but not social or psychological hypotheses like gender hypotheses, which, because gender consists of social, psychological, and cultural properties,[39] requires a different *explanans* from what molecular genetics can provide. Like Baron-Cohen, Sánchez and Vilain (2010) view sex to have a behavioural/psychological component. Sánchez and Vilain argue that although some have contended that social-sexual behaviour and attitudes have environmental, specifically social and cultural, influence[40]—cross-cultural and multinational studies have found significant differences in "sexual attitudes and behaviors between the sexes" (Sánchez and Vilain 2010, 66). The cross-cultural and multinational studies they cite were conducted by psychologist David P. Schmitt (2005) and psychologist Richard A. Lippa (2009), which suggest that universally women and men hold quite different approaches to sociosexuality (i.e., individual differences in the tendency to engage in causal and non-committed sexual relationships)—and have different sex drives.

Importantly, however, these studies both rely on self-reporting.[41] Self-reporting does not yield the most accurate data given that research subjects can be motivated to confirm gender stereotypes—this phenomenon is referred to as response bias (Rosenman et al. 2011; Nosek et al. 2009; Blair 2001; Lemm 2005). Robert Rosenman, et al., explain that there are, "many reasons individuals might offer biased estimates of self-assessed behaviour, ranging from a

[39] There is a near consensus in the philosophical and social science literature that gender is social, cultural, and psychological (Haslanger 2000; Mikkola 2011; *American Psychological Association* 2015).
[40] Sánchez and Villain cite Anne Fausto-Sterling (1993) and Rebecca Jordan-Young (2010).
[41] Lippa's study relies on data collected from a BBC Internet Study where participants self-selected, which he acknowledges has limitations as a representative sample in terms of wealth, youth, and education.

misunderstanding of what a proper measurement is to social-desirability bias, where the respondent wants to 'look good' in the survey, even if the survey is anonymous" (Rosenman et al. 2011). Due to the possibility of response bias, relying on self-reported data, even for cross-cultural and multinational studies, can render those findings less compelling. The upshot here is that Sánchez and Vilain hold that sex-differentiation includes behaviour and they rely on, not only genetic findings to make a case for the development of sex-based behaviour, but they also rely on studies that use self-reported data to show that sex-differentiation in social-sexual behaviour among humans is universal. Relying on genetic findings and on psychological studies that are subject to biasing effects that skew toward sexual selection narratives do not help to adequately explain whether or how behaviour like sociosexuality is sex-based, gender-based, or both. The next chapter will deal more closely with the SEX concepts that Sánchez and Vilain and Baron-Cohen put to use in their research, and the explanatory problems that those concepts present.

10. Conclusion

The idea that sex-determining genes on the sex chromosomes explain biological traits at higher levels *and* that genetic information on the sex chromosomes explains behaviour informs a gene's-eye- (or at least, genes-focused-) view of sex development. I have outlined that there are problems with this view, viz., that it only accounts for male sex development. I have also criticized Baron-Cohen's causal inclusion thesis for genetic and hormonal effects on sex development, given that sex's determinates are multiply realized. My discussion of sex's causal powers in this chapter are important to the work I'll do in criticizing Baron-Cohen's causal picture of sex development in Chapter IV, and in offering my alternative metaphysical account in Chapter V. Now that I have surveyed some of the genetics literature, and have shown that the

history of the chromosomal sex concept is complex, and at times fraught, I shall turn to considering the proliferation of sex concepts in contemporary research spurred, in part, by gender-based brain studies.

Chapter IV—Layer Cake and 3G Sex Models

1. Introduction

The twenty-first century has seen a rise in the study of gender differences in the brain. Specifically, the idea that women and men have distinct *types* of brain has gained traction. Contemporary gender-based brain studies (GBBS) assert that there are two distinct types of human brain sex—the male *systematizing* brain and the female *empathizing* brain. According to GBBS, brains develop as either male or female in utero through a linear–hierarchical developmental process activated by genes and hormones. This theory is called brain organization theory (Jordan-Young 2010). According to this theory, brains are thought to exhibit a kind of organization that determines whether an individual has a female or male brain (Brizendine 2006; Jordan-Young 2010). In addition to its prominent foothold in areas of genetics, neuroscience, and psychology, GBBS is also endorsed in best-selling popular works, is widely disseminated through popular media, and features into some education policy (Eliot 2011; Fine 2010).

Ideas about sex-differences in cognitive capacities have a long history in Western culture (Taylor Merleau 2003). In the early modern period, Nicolas Malebranche claimed that women have more delicate brain fibres, which enabled them to excel at fashion, language, elegance, and good manners, but prevented them from discerning truths, from engaging in abstract thinking, and from tackling complex questions (Malebranche 1674 [1997], 130; Fine 2010). Early brain researchers of the eighteenth and nineteenth centuries measured the size and weight of women and men's brains and postulated that women's putative cognitive inferiority was best explained by women's "smaller and lighter brains" (Fine 2010, xxiv). In the nineteenth century, locating

sex differences in the brain was utilized to support the idea that the distinct social roles prescribed for women (as passive, emotional, and nurturing caregivers) and men (as active, rational, and dynamic agents) and were natural categories reflecting behavioural capacities determined by biology.

The attempt to explain gender-based behavioural differences in terms of binary brain types remains popular (Fausto-Sterling 1993; Kourany 2010; Meynell 2012). Early researchers focused on the external proportions of brains, and some remain concerned with sex differences as they relate to the specifics of brain function and brain size. Most twenty-first-century GBBS researchers investigate differences *within* brains, using the tools of molecular neuroscience and modern brain imaging techniques. Some of the work in the field—which researchers often call 'the study of sex differences in the brain'—focuses on rodent models, viz., rats and mice. For example, one region that is extensively studied is the preoptic area, which located in front of the hypothalamus, is responsible for reproductive behaviour and aggression. Experimental work on rodents documents various structural and functional sex-related differences in the preoptic area. Modern research attempts to understand the development of sex differences in a mechanistic manner, broadly analogous with how gonads differentiate from sexually undifferentiated tissues in early development. In both rodents and humans, gonadal hormones ('sex hormones') are thought to play a crucial role in binary brain structure *and* behaviour (McCarthy et al. 2012).

This chapter outlines key claims from GBBS and assesses their adequacy. Along the way, I'll evaluate the use of (what I call) the layer cake model in GBBS. In order to do this, I'll sketch and evaluate academic and popular accounts of GBBS. Finally, I'll present neuroscientist Daphna Joel's (2012) alternative model of sex development, the 3G model, and I'll argue that 3G sex is (for the time being) a better scientific alternative.

2. Layer Cake Sex

In addition to chromosomal sex, Simon Baron-Cohen (2003) outlines five levels of sex in total:

1. Your genetic sex: you are male if you have one X and one Y chromosome (XY), and you are female if you have two X chromosomes.
2. Your gonadal sex: you are male if you have a normal set of testes (producing male hormones), and you are female if you have a normal set of ovaries (producing female hormones).
3. Your genital sex: you are male if you have a normal penis, and you are female if you have a normal vagina.
4. Your brain type: you are male if your systematizing is stronger than your empathizing, and you are female if your empathizing is stronger than your systematizing.
5. Your sex-typical behavior: this follows from your brain type. You are male if your interests involve things such as gadgets, CD collections, and sports statistics, and you are female if your interests involve things such as caring for friends, worrying about their feelings, and striving for intimacy (97-98).

On his analysis, brain type is not necessarily distinct from sex-typical behaviour, rather it is a "summary of information derived" from behaviour (Baron-Cohen 2003, 98). So, these two "levels" cluster together, or should be thought of in light of each other. He explains that brain type is a description at the cognitive level, while behaviour is what one can be observed to do. So for example, a proficiency at categorizing and organizing would speak to an individual's cognitive capacities, and along Baron-Cohen's lines, their brain type. Whereas, an interest in automobile makes and models would be indicative of one's sex-typical behaviour. To reiterate, he explains, one's genetic sex is "set at the point of conception, and is straightforward to determine. Most people who want to determine whether a person is male or female stop at this first level" (Baron-Cohen 2003, 98). He acknowledges, however, that individuals can have "mixed" sex levels, such that one can have XX chromosomes, a vulva, but testes and a "male brain and male sex-typical behavior" (Baron-Cohen 2003, 98). He also argues that testosterone has an "activational" effect on the brain, which surges between eight and twenty-four weeks of

gestation, five months post-natal, and at puberty. He describes the "sex hormones" i.e., testosterone as having a pre-natal "activating effect" on the brain (Baron-Cohen 2003, 98).

To take stock, Baron-Cohen delineates five levels of sex where each level builds on the other in sex development, but he acknowledges that pre-natal testosterone (an androgen) is an important variable in determining brain type and sex-typical behaviour. On his view, exposure to pre-natal testosterone affects language skills and sociability after birth. Higher amounts of pre-natal testosterone lower language skills and sociability, while lower amounts of pre-natal testosterone increase language skills and sociability. Baron-Cohen cites a study he conducted with his then PhD student Svetlana Lutchmaya and Cambridge biochemist Peter Raggatt (2002). The study evaluated the same group of 70 children (29 girls and 41 boys) whose mothers had undergone amniosynthesis during pregnancy. The amniotic fluid of these mothers was saved and frozen, and its pre-natal testosterone levels were later examined, and the toddlers of these mothers were brought in for investigation. The studies found that the toddlers who had lower levels of pre-natal testosterone were "more sociable" and had higher language skills, which was measured by the frequency of the of toddlers' eye contact (more eye contact) and the size of their vocabularies (larger vocabularies), respectively (2002, 2003). On the flip side, the study found that toddlers with higher levels of pre-natal testosterone were "less sociable" and had lower language skills, which was measured by frequency of eye contact (less eye contact) and vocabulary size (smaller vocabularies). Baron-Cohen notes that his findings fit with neurologist Norman Geschwind's theory that pre-natal testosterone exposure impacts the growth rate of the two hemispheres of the brain—higher amounts of testosterone yield a faster growth rate for the right hemisphere and a slower growth rate for left hemisphere (2003, 99). Baron- Cohen argues that male sex development yields superior right hemisphere skills, whereas female

sex development yields superior left hemisphere skills. Baron-Cohen contends that right hemisphere is associated with *systematizing* and the left hemisphere is associated with *empathizing*; this contention, as well as his studies, will be examined in detail in Chapter III.

Moreover, Sánchez and Vilain (2010) hold that several key biological and psychological sex differences exist between women and men. They delineate seven types of sex:

1. Sex chromosomes: the chromosomes involved in determining the sex of an organism. In humans, this consists of the X-chromosome and the Y-chromosome.
2. Sex-determining genes: genes involved in the development of male-typical and female-typical phenotypes (e.g., Sry, Sox9,and Wnt-4).
3. Gonads: the organs that produce gametes (i.e., the testes and the ovaries).
4. Gonadal hormones: sex steroids produced by the testes and ovaries (i.e., androgen and estrogen), which are involved in the development and maintenance of primary and secondary sex characteristics.
5. Internal reproductive structures: the system of connected organs involved in reproduction (e.g., the Wolffian ducts and the Müllerian ducts).
6. External reproductive structures: the external organs involved in sexual intercourse (e.g., penis and vulva).
7. Brain sex: the presence of sex-specific neuroanatomical parameters that are often the result of circulating gonadal hormones.

They maintain that although gonadal hormones serve an important role in creating many of the biological and psychological differences between women and men, emerging research shows that not all sex differences are determined by the presence and amount of pre-natal androgens and estrogens. Rather, sex chromosomes and genes serve a *direct role* in biological and psychological sex difference between women and men (73). Because they hold that sex chromosomes and genes play a direct role in the trajectories of sex development, Sánchez and Vilain clearly depart from what they refer to as the "classical view" of sex development.

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chromosomes and genes play a direct role in the trajectories of sex development, Sánchez and Vilain clearly depart from what they refer to as the "classical view" of sex development. They attribute this view to Lillie (1916), endocrinologist Alfred Jost (1970, 1983), psychologists Anke Ehrhardt and Heino Meyer-Bahlburg (1979), and Charles H. Phoenix (1959)[43], with the classical view of hormones acting on sex development in more direct ways than sex chromosomes.[44] As mentioned previously, Lillie, in particular, maintains that sex-determination and sex-differentiation are distinct, and that hormones play a unique role in sex development. To review, Lillie's account of sex development involves genes on the XX or XY chromosomes that trigger the development of one type of embryonic gonad, but from there the hormones that those gonads produce can go onto develop a variety of trajectories in sex development at genital and morphological levels. For Lillie, the actions of hormones play a key role in more typical female and male developmental trajectories and in intersex trajectories. Thus, for Lillie's account, hormones have unique causal powers in sex development.

Instead, like Baron-Cohen, Sánchez and Vilain have a view of levels of sex that follows a more linear and graduated/hierarchical causal structure. Sánchez and Vilain's and view differ from Baron-Cohen's to the degree that they outline a somewhat different list of sex concepts, but they also do not explicitly state that view in terms of "levels" of sex. However, similar to Baron-Cohen's account, they assert a gene's-eye/focused-view of sex development where genes play a direct role in sex development all the way "up to" brain and behavioural development. In order

[43] See references.
[44] It is worth noting that according to emerging research, not only do genes code for hormones, but hormones regulate genes. In particular, steroid hormones (such as cortisol, estradiol, progesterone, and testosterone) bind to intracellular receptors that act as genetic transcription factors that directly regulate gene expression (Harden and Klemp 2015).

to elucidate the causal picture of their view, some of the types of sex that they list can be clustered into groups, such that sex chromosomes and sex-determining genes are together at one level, gonads and gonadal hormones at a second level, internal and external reproductive structures at a third level, and brain sex at a fourth level of pre-natal development.[45] I have clustered these seven types of sex in order to underscore the reach of the causal effects of sex-determining genes, on their account. We can think of sex-determining genes from the first level as acting on the second, third, and fourth level—causing their development in a linear-hierarchical fashion.

Both Baron-Cohen and Sánchez and Vilain place genetic sex/sex chromosomes at the top of their list, however, in terms of the causal story that their accounts tell sex-determining genes and sex hormones are actually located at the very bottom of this picture of sex development, with brain and behavioural sex at the top, given that these are higher-level properties.[46] The properties I have grouped at the bottom: sex-determining genes and sex chromosomes, are lower-level properties because they are (biologically) more basic constituents in the human organism and in development. Whereas, brain structure or behaviour are higher-level properties because they are (biologically) more complex, and where, presumably, genes are a constituent of these properties. A simpler way to think about this is that by virtue of what genes are, brains cannot be constituents of genes, but because genes build proteins, genes can be constituents of brains.

To further elucidate the causal picture of Baron-Cohen's and Sánchez and Vilain's views of sex development and the role genes play, I'll describe this picture in terms of a layer cake

[45] These seven types of sex might be grouped in other ways, but these four groupings seem like the most straightforward approach for highlighting the causal story at play.
[46] There is a body of neuroscientists and psychologists who work in gender-based brain studies who hold a similar view of sex development, including Rebecca Knickmeyer (2002), Svetlana Lutchmaya (2013), and Melissa Hines (2011).

model. I'll call it the 'layer cake model' in light of Paul Oppenheim and Hillary Putnam's (1958) discussion of layer cake reduction in the metaphysics of science. Layer cake reductionism is a metaphor that is used to characterize how higher-level scientific theories or phenomena can be reduced to lower-level theories or phenomena. For example, according to the layer cake reduction of scientific theories, biological theories can be reduced to theories in physics. In terms of the reduction of scientific phenomena, higher-level phenomena like spending behaviour can be reduced to hormones which can be reduced to genes, which ultimately can be reduced to the most basic physical constituents—the constituents of physics. I shall not use the term 'layer cake model' to denote ontological reduction, I'll use the term to describe assumptions about causal explanation. The layer cake model when applied to sex development underscores how the development of properties like behaviour, brain structure, morphology, genitals, gonads, and hormones are causally determined by XX or XY chromosome structures or sex determining-genes.

In addition to Baron-Cohen and Sánchez and Vilain's accounts of sex development, self-described "social philosopher," psychologist, and corporate consultant Michael Gurian offers a popular account of sex development (Gurian and Stevens 2005). As a New York Times bestselling author, Gurian's account has helped to cement a notion of layer cake sex in the popular imagination.

According to Gurian and colleagues:

> Advances in brain research and neuroscience… have given us evidence that your daughter's brain has its own nature, that it's programmed by genes and evolution to function in a certain way, and that much of this will happen no matter what environmental influences you bring to bear (The Gurian Institute et al. 2009, 7-8).

Generally, popular accounts are less careful than their academic counterparts—both Baron-Cohen and Sánchez and Vilain leave room for society and culture to influence psychology and behaviour. The difference with their accounts is that they hold that although society and culture

have some environmental influence on behaviour, genes have more (entrenched) influence insofar as genes lay the groundwork for behavioural patterns and cognitive skills. Gurian's account disseminates a flavour of layer cake sex that is over-simplistic and quite damaging—epistemically speaking. Gurian's account is also potentially very damaging morally and politically speaking.[47] Neuropsychiatrist Louann Brizendine (2006, 2010), psychologist Susan Pinker (2008), and developmental biologist Lewis Wolpert (2014) also offer bestselling popular accounts. Even though academic accounts like Baron-Cohen's (2003) and his co-authors (Baron-Cohen et al. 2005; Lutchmaya et al. 2002) endorse layer cake sex and the organizational-activational hypothesis, popular accounts offer a more simplistic picture of the relationship between the properties of sex development and a harder determinism. This harder behavioural determinism includes postulating that women have special intuitive capacities due to low testosterone levels (Brizendine 2006), are less suited to leadership roles (Wolpert 2014), and an array of additional brain sub-types such as 'mommy,' 'daddy,' and 'gay' brains to in an attempt to account for variation in the female-empathizing/male-systematizing split (Brizendine 2006, 2010).

3. The Organizational-Activational Hypothesis

Similar to Baron-Cohen's (2003) view that cis women-females *empathize* and cis men-males *systematize*, popular accounts such as Brizendine's (2006, 2010) draw a tighter connection between putative sex-based behavioural properties and gender-based properties. On her account, different brain structures indicate whether one will become a *feminine or masculine person*. To

[47] Michael Gurian and The Gurian Institute advocate single gender education programs, which are meant to tailor education to children's "female" or "male" brains. Single gender education programs have been implemented in the United States and Australia (Eliot 2011, Fine 2010). Physician Leonard Sax (2005) also advocates for single gender education programs. Over 500 public schools in the United States now administer single-sex academic classes, driven to large extent by claims about sex differences in the brain and neuropsychological function, according to the National Association for Single-Sex Public Education (http://www.singlesexschools.org) (Eliot 2011).

be feminine, on Brizendine's view, is not only to empathize but to predict others' needs and desires at an incredible level of accuracy via 'women's intuition' (Brizendine 2006; Fine 2010). For Brizendine, what creates 'women's intuition' (and cis men's alleged obtuseness to emotion) is the lack of a fetal testosterone surge in utero. Like other GBBS researchers (Gurian and Stevens 2005, The Gurian Insititute 2009), Brizendine (2006, 2010) endorses the *organizational-activational hypothesis*. On this hypothesis, fetal testosterone organizes the brain to be masculine in utero, and post-puberty testosterone activates 'masculine' brain circuits, which make men suited to leadership positions, careers in science, technology, engineering, and mathematics, and poorly able to communicate and mind read (Arnold 2009; Jordan-Young 2010). Without a testosterone surge, the brain 'feminizes' rendering one best suited to communicating and care-taking based on adeptness at anticipating or perceiving the emotions of others (Brizendine 2006, 2010; Fine 2010; Jordan-Young 2010). On this hypothesis, testosterone and estradiol are the hormones leading to 'male brains' (often called 'masculinization' of the brain), whereas estrogen (and the absence of the a testosterone surge in utero and during and after puberty.

More specifically, on Brizendine's (2006) account the fetal brain starts out as unisex. In the eighth week of gestation, if a testosterone surge occurs, cells in the emotional, observational, and communication centres of the brain shrink and more cells in the aggression centres of the brain develop. If no testosterone surge takes place, then the female brain will ultimately progress from the unisex brain, developing more connections in the areas that process emotions and in the communication centres of the brain. High levels of prenatal testosterone are not only purported to minimize the capacity for affective empathy and amplify aggression in males, they also increase capacities for mathematical ability and organizational and analytical reasoning (Brizendine 2010). Brizendine, building on the organizational-activational hypothesis, is not the

only one to view such gender differences as being driven by sex hormones. As psychologist Cordelia Fine (2010) points out, hypotheses that treat higher fetal testosterone levels as the force that creates a male brain and lower testosterone levels that produce female brains—concomitant with their stereotypical cognitive properties—retain an impressive amount of support within scientific communities and popular media.

A major empirical problem with the organizational-activational hypothesis, however, is that fetal testosterone levels are very difficult to measure directly. Instead, indirect measures are used, which include checking testosterone levels of the pregnant person, testing testosterone levels in amniotic fluid, or assessing adult digit ratios. The ratio of index finger length and ring finger length (2D/4D ratio) are purported to result from prenatal testosterone levels. (Cis men tend to have longer ring fingers than index fingers, while cis women tend to have shorter or same-length fourth fingers relative to their second fingers.) Not only are adult digit ratios sometimes used as a proxy for testosterone levels during the prenatal period, they also illustrate the wide scope of the organizational-activational hypothesis: sex differences in prenatal hormones are seen to account for differences ranging from morphological traits (digit ratios) to brain organization and cognition (Valla and Ceci 2011). These diverse measurements, however, fail to indicate whether they correlate (well or at all) with fetal testosterone influencing fetal brain development (Fine 2010). With unreliable proxies, the organizational-activational hypothesis is not empirically well-founded and its sweeping explanatory agenda appears *ad hoc*—given that its evidential backing has a moving threshold. Higher-levels of fetal testosterone are correlated with having some sex-based properties such as a penis, but this correlation does not indicate that fetal testosterone levels influence an individual's behaviour along gender-stereotyped lines.

The organizational-activational hypothesis is rooted in the nature versus nurture dichotomy. Baron-Cohen and Sánchez and Vilain offer somewhat more subtle views regarding the roles of nature vs. nurture in sex/gender differences in behaviour. As noted above, however, they view genes as playing a primary role in the development of 'brain sex' and do not clearly demarcate how biological determinism vs. social environment would influence gender-based behaviour. On the other hand, Brizendine, Wolpert, and psychologist Susan Pinker (2008) assume that gender and sex differences could only be explained in terms of *either* nature *or* nurture. On these accounts, social and feminist theory have offered inadequate explanations and remedies to persisting gender disparities, e.g., the gender gap in math and science achievement, and gender-based oppression (Fine 2010; Eliot 2011; Valian 2014). So rather than asking whether there might be empirical findings on gender psychology and social psychology that could inform explanations of differences in gendered behaviour and cognition and aid the development of more effective social measures, some gender-based brain researchers pursue explanations that involve innate biological differences.

Unsurprisingly, there are a number of criticisms of the putative evidence for and the methods used to support brain organization theory, typically from psychologists and neuroscientists (Jordan-Young and Rumati 2012; Joel 2012; Valian 2014). Some of the criticisms also pertain to the study of behavioural differences in nonhuman animals, where it has been noted that although animal studies do not supply reliable inferences for differences in humans, gonadal hormones show some influence on behaviour in animal studies. Importantly, there is also evidence for social interactions influencing postnatal brain development in rodents, which challenges the vision that sex-related neuronal and behavioural differences are generally innate and independent of social context (Fine 2010). A major line of criticism for human studies concerns the claim that the many associations among structural and

cognitive traits postulated by brain organization theory do not match with, or are simply not present in, the available data (Jordan-Young 2010; Jordan-Young and Rumati 2012).

Philosopher Ginger Hoffman (2012) also points to several key scientific examples that show that there can be a brain difference between genders without a mental or behavioural difference (e.g., no difference in mental states between women and men during arithmetical reasoning assessments despite statistically significant brain differences). Hoffman argues that due to the possibility (or even likelihood) of a mental state being multiply realized in the brain—including across genders—neuroscience provides insufficient evidence to support the notion that there are fixed cognitive differences between genders. In many instances, such empirical or methodological criticisms of GBBS have been combined with overtly feminist concerns or at least sensitivity to gender essentialism and androcentric bias in research.

In what follows, I'll present neuroscientist's Daphna Joel's (2012) alternative to what I call the *layer cake* model dominant in GBBS. Joel's alternative, *3G* model, is not without criticisms (Del Giudice 2021). A major line of criticism is that Joel rejects the idea that sex develops along strictly female or male binary trajectories yet makes appeals to 'internal consistency' and 'levels' in sex development on her non-binary, mosaic[48] account (Del Giudice

[48] In more recent publications (2018, 2019, 2020, 2021), Joel argues that human brains exhibit context-sensitive mosaic characteristics that do not align with strictly female or male sex classifications. In other words, depending on contextual factors such as environmental stressors, brains exhibit more or less dendritic spines regardless of the

2021). I shall not explore the merits of these criticisms here, instead, I'll merely present how Joel provides a path forward for a more adequate model of sex development despite its potential flaws. My preferred model represents sex development as a network of properties and relations that are non-linear-hierarchical, which I'll discuss in Chapter V. What is useful about Joel's alternative model, however, is that she provides a clear epistemic framework for understanding that sex development occurs on an *individual* basis (rather than as a binary group form) and her view underscores the importance of theorizing variation among individuals.

4. 3G Sex

Joel (2012) offers an alternative model of sex development than Baron-Cohen's and Sánchez and Vilain's layer cake accounts. She refers to her (2012) account as 3G sex, and although she appeals to 'levels' of sex, she does not include brain or behavioural sex on the 3G model. According to Joel, whether one is a scientist or a layperson, "when people think about sex differences in the brain and in behavior, cognition, personality and other gender characteristics, their model is that of genetic-gonadal-genitals sex (3G sex)" (2012). Joel explains that 3G sex is a categorization system:

> in which ~99% of human subjects are identified as either "male" or "female," and identification with either category entails having all the characteristics of that category (i.e., "female" = XX, ovaries, uterus, fallopian tubes, vagina, labia minora and majora, clitoris, and "male" = XY, testes, prostate, seminal vesicles, scrotum, penis) (Joel 2012, 1).

other sex-based properties of an individual. Dendrites are finger-like cells at the ends of neurons. Dense dendrites are associated with female sex-based properties and sparse dendrites are associated with male sex-based properties. On Joel's account, it does not make sense to talk about female and male brains given that brain states are highly interactive with environment and shift between so-called female and male forms frequently. Instead, she views that each individual, regardless of their sex-based properties, have mosaic brains.

Further, she asserts that 3G sex is a powerful categorization system because it utilizes two characteristics: the first, she claims, is that there is an *almost* dimorphic division into a 'female' and into a 'male' form at the different levels of 3G sex. Joel acknowledges that approximately 1 percent of individuals do not fit into one of these two categories, though she notes that this is a conservative estimate.[49] Intersex individuals may have an intermediate form at one or more levels, e.g., ovotestis or intersex genitalia, which she claims mirrors the fact that the different levels of 3G sex are not completely dimorphic. Alternatively, an intersex individual may have the 'male' form at some levels and the 'female' form at other levels, e.g., an individual with 'male' XY chromosomes, 'male' gonads (testes), and 'female' external genitalia, as in the case of Complete Androgen Insensitivity Syndrome (CAIS). Joel holds that cases like CAIS reflect the fact that "the different levels of 3G sex are not always consistent," i.e., the levels of sex do not always follow a linear-hierarchical ordering (2012, 1-2). Moreover, the intersex condition, Congenital Adrenal Hyperplasia (CAH) is reflective of the breakdown of the ordering of 3G sex. Individuals with CAH have genetically 'female' XX chromosome complements, but due to higher levels of androgen exposure, have 'male' gonads, and 'male' genitalia. Individuals with CAH lack the testis-determining factor SRY, but still develop testes[50].

Joel argues that applying the 3G sex model to sex differences in other domains such as hormones, bodily morphology (e.g., secondary sex characteristics), brain, and behaviour "leads to the presumption that sex differences" in these "other domains obey the same rules, that are highly dimorphic and highly consistent, and that therefore belonging to a category entails having

[49] Blackless M, Charuvastra A, Derryck A, Fausto-Sterling A, Lauzanne K, Lee E. (2000) How sexually dimorphic are we? Review and synthesis. *Am J Hum Biol*. 12:151–166.
Anne Fausto-Sterling and the Intersex Society of North America estimate that 1.7 percent of the population is intersex. Philosopher Sally Haslanger (2012) cites similar statistics of 1 in 100 individuals born intersex.
[50] Simon Baron-Cohen refers to children with CAH as an "experiment of nature" and notes that medical intervention is typically carried out on children with CAH in the first year of life, along with "corrective hormonal therapy" to block androgens (2003, 102-103).

all the characteristics of that category" (2012, 2). As a consequence, she contends, humans are divided into women and men and brains into female brains and male brains. She argues, however, that the presumption of a binary dimorphism does not hold true for sex differences in hormones, morphology, brain and behaviour. She notes that, in fact:

> From the level of "sex" hormones (e.g., estradiol and testosterone), through the level of secondary sex characteristics, such as breast formation and facial and body hair, to the level of observable body features, such as height, a considerable overlap exists between the distribution of 3G-"females" and 3G-"males", and the consistency between the form of the different features is not as high as the consistency between the different levels of 3G sex. For example, about 33-50% of 3G-"males" have the "female" form of breasts (i.e., Gynecomastia) together with the "male" form of facial and body hair, and about 5-10% of 3G- "females" have the "male" form of facial and body hair (i.e., Hirsutism) together with the "female" form of breasts (Joel 2012, 2).

For Joel, even 3G sex dimorphic individuals can and do have mixed 'female' and 'male' form in terms of hormonal and morphological properties. Furthermore, regarding brain, behaviour, cognition, and personality traits, Joel argues that "current data reveal that sex differences in these domains are rarely dimorphic and are often not consistent" (2012, 2). She points to research informed by functional imaging, longitudinal, clinical, epidemiological, and epigenetic studies as evidence to support her argument that 3G sex does not extend upwards to binary dimorphism in brain sex. The studies she cites show that although there is evidence for some sex differences in morphometry (9-12% larger brain size in 3G male individuals) brain region activation, trajectory of brain development, and psychiatric disorders, the most evidence exists for difference in brain size, *and* there is not compelling evidence for the sweeping cognitive, behavioural, and personality differences assumed with the layer cake model of sex.

According to psychiatrist Rhosel K. Lenroot et al., (2010) sex differences in brain size, brain region activation, and trajectory of brain development show that these differences are present as group averages, and should not be interpreted as evidence for the relative cognitive and behavioural capacities of females and males. Drawing on these studies, Joel contends that in the

majority of documented sex differences in the brains of both humans and non-human animals, there is considerable overlap between the distributions of the two sexes. She argues that, in fact, in the human brain there is currently no region for which a complete dimorphism has been shown (Joel 2012, 3).

To take stock, Joel's 3G sex model is similar to Baron-Cohen's and Sánchez and Vilain's layer cake accounts to the degree that both kinds of model assume that there are 'levels' in sex development, and that there are causal relations between these levels. For Joel, the causal relations that establish 3G sex roughly follow a partial linear-ordering for about 99 percent of the human population. Importantly, however, for Joel even 3G sex is not completely binary, and the linear-ordering of the relations that determine 3G sex for about 99 percept of humans breaks down in the sex development of about 1 percent of humans who are intersex. Thus, Joel's 3G sex model differs from Baron-Cohen's and Sánchez and Vilain's layer cake accounts insofar as she only uses the terms 'female' and 'male' to denote developmental trajectories relatively loosely. 3G sex also differs from layer cake sex to the extent that the former only comprises three levels: genes-gonads-genitals, and makes use of what Joel deems as a "powerful" yet minimal categorization system for sex, whereas the latter appeals to a proliferation of sex concepts, particularly, notions of brain and behavioural sex, that Joel and a growing body of neuroscientists and psychologists reject.[51] Joel's et al., findings do not corroborate the layer cake model due to evidence of plasticity in brain function and behaviour in individuals who have 3G properties or are intersex.

5. Layer Cake Sex, 3G sex and Multiple Realizability

In addition to the evidence that does not support the layer cake model, I have shown that the layer cake model is conceptually flawed. In analysing the causal story the model represents, a linear-hierarchical ordering of sex from genetic sex to brain and behavioural sex does not yield a determinable/determinate relation (as discussed in Chapter III) unless one forgoes the causal

inclusion thesis[53], and adopts a more inclusive concept of gene action in sex development such that *genes on chromosomes* trigger sex development, instead of *sex-determining genes on sex chromosomes*. As I argued previously, the former conception of genetic sex is too restrictive insofar as it only accounts for (3G) male sex development and leaves out the important genetic factors that give rise to (3G) female sex development.[54] However, even modifying the concept and nomenclature of gene action in sex development would not be enough to save the layer cake model from its flaws because sex's determinates are multiply realized. Joel's 3G sex accommodates multiple realizability through delineating fewer levels of sex, and through being able to explain why an estimated 99 percent of human individuals develop 3G sex, while also being able to explain why intersex individuals have different developmental trajectories.

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[51] Lise Eliot (2011), Cordelia Fine (2010, 2017), Lesley Rogers (2011), Amy Clements-Stephens et al. (2009), Rebecca Jordan-Young (2010, 2017), Geert De Vries (2004), Janet S. Hyde (2005, 2016), Victoria J. Bourne and Adele M. Maxwell (2010), Margaret McCarthy (2005), and David I. Miller and Diane Helpurn (2014).

[52] In Chapter III, Section 2.2.d., I argue that Baron-Cohen (2003) views so-called sex determining genes on sex chromosomes as being the unique determinate of sex development where hormonal influences do not have exclusive causal powers.

[53] Neuroscientists Margaret McCarthy (2012) and Elena Choleris et al. (2018) note that there is a dearth of scientific research on sex differences that focuses on female sex; the majority of sex research focuses on male sex (2241-2242; 126).

The layer cake model does not account for multiple realizability as easily because the views that the model represents have a gene's-eye-focus, such that the lower-levels of the layer cake model are meant to determine the higher-levels, i.e., genetic-sex determines brain and behavioural sex. The layer cake model is flawed because it does not adequately account for genetic factors in development outside of XX and XY chromosomes, and even if it did, it is not flexible enough to accommodate the effects of non-genetic factors in developmental trajectories. The layer cake model is not flexible enough to do so because it represents a female/male binary in development. Even though Simon Baron-Cohen (2003) references intersex conditions in his discussion of the biology of sex, his conception of sex development is a binary system and he does not do enough highlight to the malleability of sex development. Instead, on his view, sex development 'takes a wrong turn' when there are genetic defects on the sex chromosomes (102-103). When a "genetic defect" is involved, such as with the intersex condition Androgen Insensitivity Syndrome (AIS), the hormones that go onto determine sex at higher levels (and create a female brain-type) (102). With the case of AIS, his view still follows a binary and linear-hierarchical ordering, except the trajectories are just switched if something 'goes wrong' at the genetic level.

Moreover, a central problem with layer cake sex is not only its binary trajectories, but the fact that it is *additive*, rather than *interactive*. The layer cake sex is additive due to its gene's-eye-focus of the views it represents. A model is additive if it only allows for the inclusion of properties or phenomena in a buildable relationship—where one property or phenomenon builds upon another, and because layer cake sex is linear-hierarchical, it always builds up, rather than sideways or downwards. The 3G model, on the other hand, is more flexible and can capture

causal interactions between lower- and higher-level sex-based properties[55]. For instance, it is able to capture how higher-level properties like hormones block gene expression, and thus influence phenotypic change while circumscribing the lower-level genotype. The 3G model, in other words, is built to explain epigenetic (non-genetic) factors in sex development.[56] Epigenetic factors play an important role in intersex presentations, including, as Joel notes, the 33-50% of 3G-"males" with Gynecomastia, which is caused by higher than typical estrogen levels.

As I mentioned in Chapter II, epigenetics is the study of non-genetic influences on gene expression. Epigenetic factors can be hormonal or environmental, and they can change a phenotype without also changing underlying DNA sequence. Epigenetic factors, such as hormonal factors in sex development, function in a non-linear way. As indicated above, they can block gene expression and have other phenotypic effects in the body. [57] Hormones or other environmental factors can influence both prenatal and postnatal development. Recall that the SRY gene was discovered as "testis-determining" factor, however, with intersex conditions a high amount of androgens may be present in utero regardless of whether the testes are producing them. Sociomedical scientist Rebecca Jordan-Young (2010) notes that, "hormones from other sources, such as the embryo's own adrenal glands or hormonal medications ingested by the mother, can change the usual course of events" (24). So, whether testes develop and produce androgens is a sufficient but not a necessary condition for a fetus to have extended exposure to

[54] Sex-based properties vary along continuous axes in ways that are generalizable but do not provide necessary and sufficient conditions of group membership—for instance, although on average women are shorter than men and most women have two X chromosomes, some women (both cis and trans) are taller than men and some women have a Y chromosome.

[55] 3G sex is able to explain how non-genetic factors can influence sex development without squaring the explanation on 'genes gone wrong.' Even though genetic mutations are involved in intersex cases like AIS and CAH, primarily viewing the development of these conditions through the lens of genes reinforces the causal inclusion thesis, and correspondingly, a sex binary.

[56] Another example of an epigenetic factor would be non-genetic causes of cancer such as exposure to carcinogenic substances like asbestos or cigarette smoke.

prenatal testosterone or to develop a penis. Thus, epigenetic factors can circumvent gene action and affect sex development. In this way, hormonal factors can have symmetrical causal relationships to genetic factors, which reflects their non-linearity.

The existence of a variety of intersex cases is evidence that sex development includes diverse, non-linear causal processes. The existence of intersex individuals alone is enough to reject the layer cake model, as intersex cases point to the inadequacy of layer cake sex to comprehensively track causal processes in the biology of sex. That is, as the biological evidence shows, there are no necessary one-one causal relations in sex development. The 3G model reflects sex's multiple determinates. The layer cake model represents linear-hierarchical relationships, but due to variation in sex development, namely between the influences of genes and hormones on gonads, genitals, and morphology, this account is unacceptably simplistic. In my view, because GBBS has education, labour, and health care ramifications (Eliot 2011; Fine 2010; Schiebinger 2021), accuracy is more important than simplicity in providing an explanatory model of sex development. The simplicity that the layer cake model offers obfuscates epigenetic factors in the biology of sex and does not sufficiently address variation in sex development.

For empirical reasons, viz., the existence of intersex individuals, an account of sex development that actively reckons epigenetic factors is critically important. Joel's 3G sex is more empirically adequate because it is not committed to a notion of binary sex, thus it does not effectively ignore that approximately 1 percent of the population does not fit into female or male developmental trajectories. It is also not strictly linear-hierarchical, so it is able to accommodate non-asymmetrical relationships between genes and hormones in sex development. Conceptually, the 3G sex is able to satisfy the problem of multiple realizability because it accounts for multiple

determinates of sex (genes and hormones). For these reasons, we need a sex concept that can capture the dynamism of 3G or network models of sex development, and can use these empirical considerations to motivate engineering a new sex concept.

6. Concepts and Models

In Chapter II, I discussed why it's important for a concept to fit the *relevant* aspects of reality. I explained that we can use concepts to represent those aspects of the world relevant to our inquiry or activities. And I held that concepts do work *for* our theories (as well as work within our theories). In this section, I'll explain why it's important to craft an adequate model for the phenomena we are trying to explain. Empirical adequacy is crucial to developing a concept with evidentiary fit, but empirical adequacy is not the only pertinent criterion for developing a new concept for a scientific kind. For Helen Longino (2002), empirical adequacy is the single standard that is relevant to all scientific investigations. She argues that empirical adequacy is integral to scientific investigation so that we may understand the world we live in and "interact with it successfully" (2002, 185). On her view:

> We cannot interact successfully without a model whose observational elements correspond to some extent to the phenomena in the world with which we wish to interact or with which we must interact in order to engage in the interactions we desire. And whether our interactions are successful depends on our particular aims with respect to the portion of the world with which we interact. Someone's leaping off a bluff and falling to the ground will count as successful or unsuccessful depending on whether their aim was flight or reaching the next level down. So, of course, as long as a community has interests in interacting with the world, empirical adequacy will figure among cognitive standards (185).

Here Longino (2002) argues that we need a serviceable model in order to interact successfully with the world. A serviceable model (one that enables us to explain and predict) contains observable phenomena that captures the aspects of the world (at least to some extent) that we *want* to interact with (or those that we *must* interact with *in order* to facilitate the interactions we

want to have). Empirical adequacy involves observables that are preserved within the structures delineated by a scientific theory. It is my contention that an empirically adequate model of sex is not only desirable but is also necessary to achieve the types of interactions we want to have with the world. It is worth noting here, however, that I take empirical adequacy to be necessary but not sufficient for choosing a model of sex. Our aims for choosing a model are important as well (Anderson 1995; Intemann 2015). In the case of sex, the 3G model is sufficient because it, first, enables us to explain and predict flexibility and variation in sex development. Second, it enables us to engage with that flexibility and variation in sex development in order to address the social consequences that come with having sex-based properties.

In addition to problems with empirical adequacy, the layer cake model suffers several important epistemic failures. It is unacceptably coarse-grained in the sense that it lumps diverse trajectories of sex development into a binary (i.e., it lacks ontologically heterogeneity) (Anderson 1995; Longino 1996). Further, it ignores that there are multifactorial causes in sex development and networks of causal relationships including sideways and downwards causal relationships and epigenetic effects (i.e., it lacks complexity of relationship). Incorporating epistemic values such as internal coherence and accuracy along with non-epistemic values like heterogeneity and complexity are important for yielding not only an empirically adequate theory of sex development, but also an unbiased theory. Having an unbiased theory of sex development is just as important as an empirically adequate one—for both epistemic and social reasons. The epistemic reasons are as outlined above—a good theory and its models yield accurate predictions and has explanatory power. There are also moral and social-political reasons for replacing a biased model (and its theory) in favour of an unbiased one. Philosopher Elizabeth Anderson

(1995) argues that there are cognitive (epistemic) and political motivations for valuing heterogeneity and complexity in theory choice and scientific practice. On her view, having an epistemic interest in capturing complexity in nature in a fine-grained manner complements a social or political interest in representing, for example, social dynamics in a cohesive and interconnected fashion that aims towards accuracy and completeness. Accurately describing social complexity, like uncovering complexity in the rest of nature, involves accounting for factors and relationships that are multifaceted and dynamic (Anderson 1995, 31). Complete and unbiased accounts of sex development have to meet standards of empirical adequacy but also require the incorporation of values that seek to uncover complexity and diversity among sex-based properties and their causes.

7. Conclusion

In short, the problem with the layer cake model is not simply that it is empirically inadequate, but its failure to capture how sex development is multiply realized in different properties, including epigenetic factors, is a result of pretheoretical assumptions in the research question. It is easy to ignore a phenomenon that we were not looking for at the outset, e.g., to label diversity in sex development as development gone "wrong," as in Baron-Cohen's (2003) case, than the relevant research questions and model. As I argued above in Section 2., apart from its discreet binary trajectories, the layer cake model assumes a causal trajectory that is *linear-hierarchical* and *long-reading* (from 'genetic sex' all the way up to cognition and behaviour). In Chapter V I'll counter the ontological picture that the layer cake model represents by offering my account of sex as a dynamic emergent process that features non-linear-hierarchical networks of properties and relations. And in Chapter V and VI, I'll continue to challenge Baron-Cohen's

causal inclusion thesis[57] by showing how sex and gender are distinct, and that sex assignments (and their classification schema) are a social practice geared to initiate people into a (binary cis) gender role.

It is in our epistemic and moral/social-political interests to acknowledge sexual diversity where it exists. Doing so enables us to recognize diversity as a relevant factor in creating a model of sex development. In this way, our model does the work of accurately representing a feature of the world, which includes the aim of mapping all of the *relevant* features. *All* features of sex development are the relevant ones—not only the purported female-male binary features and not only the 3G features. According to biologist Anne Fausto-Sterling (1989), adherence to a sex binary leads "researchers to ignore data which are better accounted for in approaches which accept the existence of intermediate states of sexuality" (326-327). Fausto-Sterling argues that gender bias thwarts the development of a "coherent theory" of sex determination. Instead, she proposes an alternate model of sex development that incorporates both female and male associated pathways along with intermediate states (1989, 330).[58] Our models of sex have ontological and normative implications. Ironically, our models (like our concepts) can circumscribe the world we live in, especially the lives that inhabit that world, even though the world (on a realist approach) is supposed to constrain our theories. In the next chapter, I'll transition from the epistemic task of weighing scientific models of sex development to offering my metaphysical account of sex as a dynamic emergent process and introducing its normative implications.

[57] Where the causes of higher-level features of sex development as well as behaviour and personal preferences are determined by sex-determining genes on sex chromosomes.
[58] Geneticists Eva Ficher and Linda Washburn (1986) put forward a model of sex determination that incorporated ovarian development and proposed that many genes interact along complex and overlapping developmental pathways to give rise to female and male gonads (Fausto-Sterling 1989; Richardson 2013).

Chapter V: Island Metaphysics and Emergence

1. Introduction

In this chapter, I shall explore what sex is as a kind. I'll make two key claims: that sex is a biological kind and sex development is a dynamic emergent process. This chapter contributes an alternative view of the metaphysics of sex in terms of causal and constitutive features. This chapter is the companion to Chapter VI, where I'll engage in strategic conceptual engineering to offer my nonbaptismal SEX concept. In what follows, I'll build my case for why sex is biologically constituted with a use of a thought experiment I call *Sex on a Desert Island*. The role that *Sex on a Desert Island* serves is to illustrate my preferred real definition and to highlight the normative potential for us to detach many of the social meanings we assign to sex-based properties in practice. In Chapter VI, I'll argue that there are normative benefits to deflating gender stereotypes associated with sex-based properties. I shall contend that these stereotypes are proselytized within the culture and that most social labels for sex-based properties serve to initiate members of society into a gendered economy that has a quasi-religious character.

In this chapter, present my thought experiment in an attempt to demonstrate the potential for humans to intervene in the ways we talk about sex and regard it in practice. I believe that there is potential for humans to detach many of the social meanings we assign to sex. Doing so, I suggest, would enable us to eliminate (or at least minimize) the social practice of categorizing humans on the basis of sex in (non-reproductive) social contexts. My thought experiment is geared to set the stage to deflate sex's social properties for moral, social and epistemic aims. In what follows, I'll also offer my causal account of sex development as a dynamic emergent process.

2. Sex on a Desert Island

Let's consider a scenario in which the technologies of the future enable humans to develop from fetus to adult in pods. I'll call these humans 'pod humans.' Let's say that there's a particular pod human called 'Justice' who has never interacted with other humans because Justice has lived their entire life (thus far) in a pod. Let's suppose, by way of these future technologies, Justice is transplanted from their pod onto a desert island.

Now I would like us to consider Justice on the island. What is Justice like? Aside from having questionable survival skills, does Justice have a sex? Do they have a gender? Next, I would like us to think about whether Justice has a sex due to being a human organism that developed in a pod. What would having a sex as someone who developed in a pod consist in?

My answer to this question is that Justice shares the same basic developmental properties that all humans do in virtue of being a human organism. Those basic developmental properties include having (or having had at some point in one's life history[59]) some configuration of the properties of sex development. Through the course of their life history, Justice has (has had or will have) some arrangement of genes, gonads, genitals, hormones and morphology just as they would have other organs and a blood type.

As I mentioned in Chapter I, I favour a metaphysical account of sex that specifies what sex is from a human developmental perspective. The real definition I proffer, that sex is constituted by the properties of sex development, is an essentialist thesis but is also deflationary in the sense that it does not posit that sex consists in particular developmental trajectories. The reason for this is that the latter is a causal notion, and further, to state that sex 'is biological' as a real definition simply picks out 'is biological' as a core essential feature of sex that is

[59]By 'life history' I simply mean the relevant diachronic properties of an individual organism.

independent of the particular developmental (or social) circumstances of the human organism. That is, the causal factors involved in the particularities of *how* sex development occurs or whether one undertakes, is subjected to, or otherwise experiences changes to one's sex-based properties, these factors do not bear on the matter that being a human requires that one has, has had, or will have some sex-based properties just as one will have other biological properties.

At this point, I would like us to return to the question of whether Justice has a gender. Justice has spent all their life in a pod until being dropped on the desert island. Justice has never been a part of a social community so they have not entered into social relations or come to understand themselves in relation to social attitudes or practices. Because I endorse the sex/gender distinction, conceiving that Justice has a sex on the desert island but not a gender is straightforward. For those who do not endorse a distinction between sex and gender, however, there are at least two possible responses to the issue of whether Justice has a sex or a gender: what I'll call the *gender reductionist* and the *sex discursivist* responses.

For the *gender reductionist* who views gender as a linguistic representation for sex but nothing more, Justice would have a sex and a gender, but their 'gender' would simply be a linguistic representation that tracks sex. I attribute the *gender reductionist* view Baron-Cohen (2003) who uses sex and gender terms interchangeably and who postulates that genes determine brain sex, which determines sex typical behaviour/behaviour associated with women or men. For the *gender reductionist* Justice would not have a gender in an ontological sense, and it is not clear what sex would consist in, or whether, depending on the contents and scope of the definition in question, Justice would have that sex. For example, since Baron-Cohen's account of sex[60] incorporates expressing fairly pronounced and specific social differences, Justice may not

[60] Baron-Cohen's definition of brain sex incorporates the expression differences based in social interaction. Of course, I am sceptical that humans in non-desert island contexts exemplify Baron-Cohen's account of sex.

be a candidate. In the alternate case, the *sex discursivist* views sex and gender as the same but holds that Justice has neither a sex nor a gender since they are not a part of a social or linguistic community. My response to this view is that even though a common language or shared attitudes about biological properties are absent on the island, this does not entail that the *properties* are also absent. Let's consider the blood type example. Biologist Karl Landsteiner discovered the main blood group system (ABO) in 1900 and in doing so realized why some blood transfusions are successful and others are not (Farhud and Zarif Yeganeh 2013). Before there was a common way to think, talk and implement practices regarding blood types, arguably the *properties* of the types still existed since the presence or absence of certain antigens led to adverse immune responses in blood transfusion recipients before the discovery and labelling of the types. The blood type case and the sex case are not equivalent but they are analogous in the sense that both involve properties that are socially significant, i.e., blood transfusions, which require blood type compatibility, have social, moral and practical significance (for instance, one may object to blood transfusions on religious grounds and knowing someone's blood type might save a life). And both have properties that are theoretically important and have causal powers (e.g., steroid hormone production in the gonads or triggering an immune response) independent of our knowledge or linguistic practices regarding them. I'll address the discursivist response further when I discuss 'the historical objection' and the encroachment of solipsism in Sections 2.1, 3 and 3.1.

Further, my response to *Sex on a Desert Island* is that Justice can have epistemic and mental states as well as embodied experiences with respect to their sex-based properties, but those sex-based properties will not include social properties since one acquires social properties in virtue of being socially embedded. And one attains biological properties (like blood type) in

virtue of being an organism that undergoes development. My proposal is that what marks the difference between sex and gender is that gender is constitutively social but without interacting in social relations, one does not develop a gender identity, is not attributed gender roles, and is not evaluated (or self-evaluated) in accord with gender norms because all of those social properties are relational properties. I'll argue in Section 4 that the reason for this is that sex development is not constituted by, but rather is only partially caused by, social properties and relations. Questions about constitution concern *what* something is. Questions about causation, on the other hand, concern *how* and *why* something is. Sex's social properties and relations explain *how* and *why* sex means what it does to us. Sex's social properties and relations explain sex's normative significance.

On the desert island, however, what remains are the 'leftovers' from the abstracted away social properties. Those leftovers are *what* sex is physiochemically. Without social properties and relations what remains is sex's biological properties, relations and their biological alterations. This is a constitutive claim as well as a claim about sex's ontological dependence[62]. If it is the case that Justice's biological properties remain on the island after social properties are abstracted away, then this suggests that sex's dependence on the properties and relations of sex development are *constant.* In this case, constant dependence can be understood as follows: necessarily, whenever sex exists, the properties and relations of sex development exists. Conversely, the desert island case reveals that sex's dependence on its social properties is not constant, nor given the right technologies, even historical.[63] Furthermore, in principle, the social

[62] It is widely assumed but not universally accepted in the literature that constitution is a dependence relation (Kovacs 2020).

[63] *A* is historically dependent on *B* if *A* requires *B* in order to come into existence. In the case of sex, sex is historically dependent on social properties, e.g., some social interaction(s) that facilitates the development of a zygote into an embryo and into a fetus, which undergoes sex development. In the desert island case, the social facilitation of Justice into a fetus (and later human adult) is potentially so far removed that it might be the case that

ascriptions often attached to the properties of sex development (like genitals) are contingent in terms of their particular content but more importantly are contingent as *properties*. In everyday non-desert island contexts, sex's social properties *are salient* because they have causal influences and histories.

In short, despite the current state of affairs regarding sex, I hope my thought experiment enables us to see that sex's social properties are not constant and the desert island case challenges us to consider whether and how sex's social properties can be rendered non-salient (or only minimally salient) and what the potential benefits or harms might be. Through the thought experiment we are given an opportunity to conceive of the decoupling of sex from gender but also to conceive of decoupling sex's biological properties from its social properties. We are invited to consider a scenario in which sex exists removed from conflations with gender and removed from the causal influences of the social world. It shall be my suggestion in Section 5 that there may be serious advantages to deflating sex's social properties in ordinary social and institutional contexts.

2.1 The Historical Objection

One might challenge my proposal that Justice still has a sex by pointing out that the label 'sex' is one that has particular historical properties—historical properties that are relevant to categorizing sex in ordinary (non-desert island) circumstances. I'll call this *the historical objection*.[64] According to this objection, our sex categories depend on particular socio-historical properties such that were we to attempt to abstract them away we would no longer be talking about sex. On this objection, sex cannot be separated from its history. In other words, like

sex is historically dependent on its social properties in only a trivial sense. And rather, the future technologies are the relevant historical dependencies.

[64]Many thanks to students and colleagues at the University of Oregon for raising this line of objection.

gender, sex cannot be said to exist on the island because the social and historical conditions that enable sex categorization in the actual past and present state of affairs do not obtain on the island. I think there are two main problems with the historical objection.

The first problem is that this line of objection endorses a notion of socio-historical modal essence that ends up attributing our past socio-historical conditions as well as past categorizations of sex as necessary. I suggest that the kind of historical dependence endorsed on this objection is a rigid historical dependence where sex can be said to depend on the *particular* social conditions that compelled our sex categorizations. When something is rigidly historically dependent, i.e., a daughter on her parents or a table on its materials, they are so dependent in virtue of having *specific* parents or *specific* materials (Thomasson 1999; Kripke 1980). On the historical objection, we cannot meaningfully talk about sex without its specific historical context. I believe what underlies this first problem, however, is an unwarranted assimilation between the socio-historical properties of sex and the socio-historical properties of race.

Cressida Heyes (2006) points out that there are important disanalogies between sex and race. Roughly, according to Heyes (2006), sex and race are not analogous because sex lacks the ancestral features that are central to our conceptions of race in, for example, North America. Such ancestral features are treated as heritable traits that derive from one's ancestral lineage, which (unlike changing sex) makes changing race impossible (Botts 2018a, 2018b). The "one-drop" rule in the United States is a prime example of whether and how someone counts legally and socially as Black. A construct of colonial enslavement and segregation, the one-drop rule identifies a person who has *any* Black ancestry as Black. No other racial category is defined in such strict yet nebulous terms in the US or elsewhere (Blay 2021). The one-drop rule adheres what it is to be Black in at least one ancestor and is geared to render other properties such as

phenotypic presentation, culture, and avowal of community inessential to being Black. The one-drop rule renders what is to be Black as essentially historical, viz., ancestral. Other race classifications for people of colour in North America, although not as stringent as the one-drop rule, function in similar ways, viz., someone's being Latinx or Asian adheres in one's ancestral properties. Race adheres in ancestry such that even mixed-race persons who are able to *pass* as White are *not* White in a metaphysical sense given the ways that ancestry is treated as essential to the racial kind that one belongs to.

Sex, on the other hand, is *not* essentially historical. Heyes (2006) rightly points out that unlike race sex is not conceptualized as a property one inherits from one's parents or their forbears. Sex, instead, is ordinarily conceptualized as an individual property of the body. Sex is often treated as an individual bodily property such that one's sex adheres in one's body (rather than in one's ancestral past). Heyes (2006) highlights that trans-exclusive (Raymond 1980) and trans-inclusive (Overall 2004) feminists alike conceptualize sex as adhering in the body. In the case of the former, sex adheres essentially to one's gender identity such that on trans-exclusive views there is something essential about having a penis that makes one male and thereby a man. Such views treat anatomy as behavioural destiny and assume that having male-oriented sex-based properties *causes* one to enact sexual violence (Dembroff 2020a; Zanghellini 2020).

Heyes (2006) also criticizes trans-inclusive feminist accounts of sex as an individual property of the body by highlighting what it means to have a sex (or a race) is socially embedded. Simply put, what it means to have a sex is shaped by our medical and psychiatric institutions. According to Heyes (2006), even for the trans-inclusive view, conceiving of sex as the passive material upon which one's sex presentation can be shaped to fit one's gender identity

misses the context of power relations in which we come to understand ourselves and our bodily properties. For Heyes (2006), a feminist genealogical understanding of sex (and race) is needed in order to better articulate a feminist ontology of sex and a feminist ethics of changing sex. On her account, even though the common feminist understanding of sex is ahistorical, sex is actually embedded in social-historical locations that are *different* from race, but are still significant for theorizing about sex in a way that acknowledges the complex ways that our identities as gendered and sexed persons are shaped by the histories and mechanisms of our institutions.

What is useful about Heyes' (2006) view for my purposes is that she targets the important differences between sex and race—their distinct social and historical properties. Even though sex has historical properties, those properties are not rigidly historically dependent.[65] In other words, the factors that contributed to sex's medical and psychiatric schemas (Heyes 2006; Richardson 2013) in the twentieth century are not necessary to sex (they are merely contingent). I am very sympathetic to Heyes' conclusion that clarifying the metaphysical differences between sex and race is important to responsibly theorizing about the ethical bounds of sex and race transformations. The point at which I part from Heyes, however, concerns her criticism of sex as a bodily property. In the following section, I'll argue that we can legitimately conceptualize sex as bodily *properties* that one has, has had or will have over the course of a life history due experiencing sex development without dismissing the significance of sex's socio-historical properties. In other words, circling back to the thought experiment, we can correctly assert that Justice has a sex on the desert island without also dismissing that sex has the *capacity* to have or be impacted by social properties and does have socio-historical properties in ordinary non-desert island contexts.

[65] That race in a US context is rigidly historically dependent on ancestry is specific to the US context.

Lastly, my thought experiment sheds light on the *contingency* of sex's particular socio-historical properties (despite their significance). In my view, acknowledging the contingency of sex's social and historical meanings supports normative aims. The dramatic history of sex's classification schemes in genetics, endocrinology, medicine, psychiatry and neuroscience is important (Jordan-Young 2010; Richardson 2013; Fine 2017), but our past and current classification schemes should not determine our future schema.

3. What Constitutes Sex

In the following section, I'll unpack what I see as sex's causal vs. constitutive features. I believe that *Sex on a Desert Island* helps illuminate the properties that sex depends on. Drawing on the distinction Petri Ylikoski (2013) makes between causal vs. constitutive dependence, I shall defend the position that sex's biological properties are constitutive, whereas sex's social properties (e.g., what it *means* to have a penis) depends on particular kinds of social conditions (i.e., a causal setting), and are thus not constitutive. If sex's social features are not constitutive, then what are they? I propose that they are merely causal because they play a role in questions about *how* and *why* sex is categorized in the ways that it is, rather than *what* sex is across possible states of affairs. That is, if sex's social properties were constitutive, Justice wouldn't have a sex on the desert island. Similarly, in another possible state of affairs where, let's say, Justice lived in a place where they and their community members didn't have words in their language to refer to sex, Justice (and others) would not have a sex there either. It strikes me that there is something solipsistic about this result: that an organ exists or is a property of someone's body does not require the presence of a shared language or a wider social setting to talk and think about the organ.

To illustrate my claim further, let's swap out sex for skin on the desert island. Justice, in virtue of being human, has skin on the island. Removed from a social context all their life, however, Justice has no race-related associations with their skin. After all, there are no races on the island and Justice hasn't been exposed to categories of race, racism, or colourism living in the pod. What this swap highlights is that one can have a biological property (or set of properties) that in ordinary circumstances are imbued with social values, but when those values are not part of the environment that a biological property, like an organ, is present in—the organ still exists.

The upshot is that biological properties, whether it's human skin or the properties involved in sex development, do not depend in a *constitutive* sense on the past or current social contents ascribed to them. Past and current attributed social contents are part of the *social setting* that biological properties are present in. In virtue of being in a racist or colourist social context, skin has the *causal capacity* to lighten via skin bleaching treatments, and thus feature into explanations about *how* skin lightened or *why* the skin was lightened, but lightening is not *what* makes skin the thing it is (Ylikoski 2013, 279). Rather, the *what* question gets at a constitutive answer about cells, layers, and ratios of water, fat, protein and minerals.

The implication I am drawing with this example is that where ever the constituents of skin appear, skin will be present too. I propose that the same goes for sex: removed from contexts where social values are attributed to genitals, chromosomes, gonads, hormones and morphology, those constitutive properties remain. And this is why Justice *does* have a sex on the island—the biological properties remain even though social properties are absent. At this point, I've claimed that biological properties *constitute* sex. In what follows, I'll unpack how biological *and* social properties *cause* sex.

4. What Causes Sex

At this point, I've set out to *strategically* decouple sex from its history. Here I'll provide further reasons for us to think that such a task is (metaphysically) possible and (normatively) desirable. This section focuses on the biology of sex and why it is beneficial to conceive of sex in terms of the properties of a dynamic developmental process rather than as a static (and binary) property of the body. My aim is to foreground the biology of sex as crucial to the ontology of sex. There are two ways to talk about sex through the lens of the biology of sex: developmental and evolutionary perspectives.[66] For my purposes, I'll focus on sex from a developmental perspective since the evolutionary perspective, which posits a sex binary between female and male reproductive cells (ova and sperm) is too narrow to account for variation in trajectories of sex development. I am interested in sex from a developmental perspective because the *properties and relations of sex development* are what I take to be 1) a source of confusion between sex and gender, and 2) a point of conflation between sex and its history. There are a number of biological determinist claims ranging from work in Baron-Cohen's work on the "essential difference" between women and men (2003) to arguments from gender critical feminists such as Kathleen Stock (2018a, 2018b) that posit that sex-based properties determine gender-based behaviour, e.g., the presence of XY chromosomes, a penis and testicles and higher androgen levels predispose one to engage in masculine-coded behaviours like violence and aggression (Jordan-Young 2010).

[66] For Muhammad Ali Khalidi (2021) sex is a candidate for a natural kind because in anisogamous species there are two types of gametes: large (ovum) and small (sperm). Biologists refer to the morph that produces the larger gamete as *female* and the morph that produces the smaller gamete *male*. Khalidi holds, "the basis of the female-male distinction in animals is the relative size of the gametes and the type of gonads that produce them…" On his view, *if* gamete size causes other putative sex differences such as morphology or behaviour, then *female* and *male* are natural kinds. In other words, Khalidi maintains that on a *simple causal theory* of natural kinds, if possessing either ovaries or testes, which produce ova or sperm, is the causal property that gives rise to a number of morphological or behavioural traits across a variety of animal species, then *female* and *male* are natural kinds.

In this section, I'll set the stage for my alternative causal picture of sex development as a *dynamic emergent process*. What I hope to illustrate in what follows is that the history of conceptualizing sex in scientific and clinical contexts, as I explored in Chapter III, is not just socially embedded but ripe with dubious and arbitrary twists and turns—such that a forward-looking understanding of the metaphysics of sex need *not* and should *not* be theorized as essentially dependent on this history. I'll present an alternative model of sex development as a network of properties and relations that features multiple directions of causation. More specifically, I'd like us to consider the advantages of characterizing sex development as a complex system that is non-linear, non-hierarchical, and non-additive (such that genital and gonadal development can't be said to rigidly depend on genes on sex chromosomes). In rethinking sex, I draw on Sandra Mitchell's (2012) account of emergence for biological phenomena.

Mitchell (2012) defines the contemporary scientific sense of emergence as involving an interaction among the parts of a system that none of the individual components is responsible for. Instead, the interaction among the system's parts gives rise to higher-order properties of the system that have causal efficacy, i.e., novelty. On her account, these novel causal powers do not preclude explanation, but what is ontologically interesting about them are the ways they are grounded in multiple forward and reverse feedback loops that are responsive to the initial and evolving conditions of the system. In this sense, her account of the causal relations of biological systems is *dynamic*. Mitchell's notion of emergence is situated in direct contrast with the feed-forward linear causation characteristic of the layer cake model of sex development.

With my acknowledgement of sex's messy conceptual history in mind, I'd like us to further consider what it would mean for sex to be stripped down to the biological properties and

relations involved in sex development. We took a first pass at this possibility when we considered Justice's properties on the desert island. Let's consider why and how it would be beneficial to think of sex in terms of the properties of sex development from a causal standpoint. In the first instance, there are many properties and relations that feature into an individual's sex development, and these properties and relations are shown to feature some non-binary trajectories. They are also shown to change over the course of a life history and in relation to environmental stimuli.

Sex development is a process in which an individual undergoes changes to the properties they have over time as a member of a sexually reproducing species (but such properties do not necessarily imply reproductive capacity). The properties of sex development change for endogenous and exogenous reasons related to hormonal influences. Social norms can also change one's sex-based properties via institutional interference (i.e., the medical management of intersex children), gender-affirming resources such as hormone therapy, etc., or even via plastic surgery or exogenous hormones to alter one's morphological features in order to comply with gender-based aesthetic norms. What I'd like to flag here is that social properties can have *causal* influences on the properties of sex development, but social influences and the material being influenced (and perhaps purposefully *reshaped*) are not one and the same. On a network or complex system understanding of sex development, development can occur without the influence of such social properties.

What will thinking about sex development as a dynamic and emergent process contribute? Characterizing the properties and relations of sex as dynamic has the benefit of capturing the non-linear and non-hierarchical causal feedback loops involved in interactions between various genes on chromosomes, hormones and social and environmental contexts. In

addition, rethinking sex development as emergent, rather than a static individual property of the body, has the benefit of acknowledging the influence of social and environmental factors while not treating such factors as socio-historical essences that determine what sex can be. In the spirit of Heyes (2006), it is, of course, the case that we humans cannot reconceptualize sex to be whatever we want since reality (informed by lived experience) constrains the transformations of our categories (and of who we can be). In rethinking sex development as an emergent process—instead of as a gene-driven static property or a sex/gender compound that is socially and historically determined—we open up a more clearly paved avenue for *radically moving away* from the epistemic error and moral harms of our past *and* present conceptualizations of sex as fixed binary properties that have strict bottom-up causal influences on our social and psychic lives.

Building on my discussion of multiple realizability in Chapters III and IV, I'll argue here that sex development is a network of properties and relations that features multiple directions of causation. I propose that sex development is best understood as a *process*, that due to its network of lower- and higher-level causal powers, is *dynamic* and *emergent*. I'll first define what a *process* is and what role(s) *causal powers* serve on my analysis. I'll then explain why both biological and social *causes* feature into explanations of how and why an individual has a sex. And lastly, I'll unpack why sex development as a process is a dynamic and emergent one that *causally depends* on biological and social properties and relations.

Processes track changes in an object or a system. Generally, a process is a naturally developing or artificially designed sequence of changes to the features of an object or system. A biological process can be described as any biochemical reaction or other activity that leads to a transformation or a change of state in an organism. Sex

development is a biological process in which an individual organism undergoes changes to their properties in virtue of being a member of a sexually reproducing species.[67] What constitutes sex is crucial, but this is not the end of the ontological story. Processes, biological ones included, also have causes. Those causes play an important explanatory role in accounting for *how* and *why* particular sex-based features arise during the process of sex development. Given the possibility of epigenetic effects in sex development, however, some of sex's causal features are non-genetic and non-biological—instead, they are social and environmental.

There is a large literature on causal powers that I shall not be able to survey here. I'll make use of Jessica Wilson's (2015, 2021) notion of causal powers in order to build my case for why the biological properties and relations of sex development *as well as* their parasitic social properties and relations have causal powers. What is a causal power? We can think of causal powers as capacities—as types of disposition—that bring about an effect under certain circumstances. Wilson (2015, 2021) explains:

> That features are associations with actual or potential causal contributions ('powers') reflects the uncontroversial fact that what entities do (can do, relative to the same laws of nature) depends on how they are (what features they have)… Moreover, a feature may contribute to diverse effects, given circumstances of its occurrence (which circumstances may be internal or external to the entity possessing the feature).

For my purposes, what's pertinent about Wilson's notion of causal powers is that what an object or entity *does* depends on its capacities, and such capacities may produce diverse effects relative to context. Applying Wilson's account of powers, the matter at hand for me concerns how sex development's causal capacities are able to produce emergent properties not determined by lower-level genetic properties. There is a trivial sense in which higher-level sex-based properties such as genitals and morphology causally depend on an individual's underlying genetics (as well

[67] Such properties do not necessarily indicate and individual's reproductive capacity.

as on one's being a member of a sexually reproducing species).[68] These trivial dependencies, however, do not account for the development of a penis in the causal backdrop of having XX chromosomes. These trivial dependencies have a causal contribution, but they're not the *difference-making* cause. In thinking about emergent properties, the *significan*t causal dependencies matter more, which are associated with actual difference-making causes. Difference-making causes are important because their presence is required to identify candidates for emergent properties. The upshot here is that both biological and social-environmental causes are implicated in sex development, i.e., a fetus's prenatal hormonal environment can be the difference-maker in terms of developing a penis rather than the SRY gene on the Y chromosome.

5. Sex Development Emerges

At this juncture, I'll take a second pass at characterizing emergence for my purposes. As is the case with the causal powers literature, there is a rich body of work on emergence that I do not have space to survey here.[69] What I'll do instead is draw on O'Connor (2020) and Wilson (2021) to briefly characterize weak and strong emergence, and then explain why I treat sex development as a case of weak emergence. The social properties that the properties of sex development acquire in social contexts may be candidates for strong emergence, but I shall not offer a defence of social properties as strongly emergent in this project.

In accounting for sex development as weakly emergent, one of my theoretical aims is to replace the static gene's-eye-view of sex development. My second aim in accounting for sex development as weakly emergent is to illuminate that theories of sex as socio-historical, which

[68] Recall that in Chapter III §2.2.d., I claimed that "*genes on chromosomes* trigger sex development" is a trivial dependence relation for sex development because "genes on chromosomes" play a causal role in all biological development. "Genes on chromosomes" does not provide a development blueprint specifically for female and male sex determination, rather a variety of causes are implicated in sex development, some of which are significant for explaining a particular phenotype.

[69] See also Ansgar Beckermann et al. (1992) (*Emergence or Reduction?*) for a survey of the literature.

appear to (inadvertently) presuppose socio-historical sex-gender[70] modal essences undertheorize sex as biological, which also has normative (viz., epistemic and social-political) consequences. On the flip side, in accounting for sex's parasitic social properties, I endeavour to highlight the causal consequences for individuals' sex-gender assignments in the backdrop of particular social contexts, viz., namely those social contexts diffused with a rigid cis gender binary. Further, in offering my novel concept of SEX in Chapter VI, I aim to shed light on the potential for us to alter sex's social properties, and thus mitigating its social significance as a biological kind, through restricting our invocation of sex in most social and institutional contexts.

In what follows, I'll characterize sex development as *weakly* emergent, but sex's social properties as possibly *strongly* emergent. Ontological emergence[71] is a philosophical term of art that aims to capture a variety of relationships between dependence and autonomy for entities or properties. There are a plurality of approaches to emergence, including its ontologically weak and strong forms, as well as different explanatory approaches that involve theorizing emergent features as multiply realizable, incompressible, non-aggregative, or distinctly efficacious (O'Connor 2020). Weak emergence differs from strong emergence to the extent that the latter involves a more robust autonomy for emergent features at the macro-level (or higher-level)[72] and weaker dependence at the micro-level (or lower-level). Strong emergence's pronounced autonomy is thought to give rise to fundamentally new causal powers, i.e., powers not held by the dependence base. Emergence, particularly strong emergence, is not without its critics (Kim 1993, 1998, 1999).

[70] I use the term 'sex-gender' here to denote instances where sex differences are conflated with gender differences. In accounts that assume that sex has a socio-historical essence, sex and gender are fundamentally co-constitutive.
[71] From now on in this chapter, I'll use 'emergence' to mean ontological emergence.
[72] I'll use 'macro-level' and 'higher-level interchangeably. I'll also use 'micro-level' and 'lower-level' interchangeably.

6. Weak Emergence and Sex Development

In addition to Mitchell's (2012) account of dynamic emergence for biological phenomena, I draw on Mark Bedau's (1997, 2003, 2008) theory of weak emergence for my account of sex development as weakly emergent. Bedau offers two accounts of weak emergence: one for cellular automata (1997, 2003) and another for natural systems (2008). For my purposes, I'll make use of his latter (2008) account of weak emergence for natural systems. For Bedau, a property or process of a macro-system is weakly emergent when it is derivable from prior facts about the micro-properties pre-emergence. Such facts are derivable only in a way that is "explanatorily incompressible" (Bedau 2008, O'Connor 2020). A feature or process is explanatorily incompressible when the relevant network of local micro-level causal interactions of a system does not explain the macro-behaviour of the system. According to Bedau (2008), "If an explanation of a macro-property of some system is incompressible, then there is no short-cut generative explanation of that macro-property that is true, complete, accurate, and can avoid crawling the causal web" (446). To crawl the causal web means to trace the origination of macro-behaviour in a system by aggregating prior local micro-interactions over time. Incompressible accounts at the macro-level cannot be replaced by accounts of the immediate goings-on of the micro-level properties.

In the case of sex development, the development of testes from androgen exposure in the fetal environment in the absence of a Y chromosome cannot be explained by the immediate causal interactions of the micro-level properties (genes on chromosomes, specifically the SRY gene on the Y chromosome). In principle, genes on chromosomes (in a total sense) explain the development of testes, but this is not a local explanation of the *particular* causal interactions in

the case of testicular development without the presence of a Y chromosome.[73] That genes on chromosomes have a causal role in various particular stages of development, including sex development, *is* the case, but this is not the relevant causal factor (what I call the difference-making cause) for how and why testes develop in the absence of a Y chromosome. In such an instance, *hormones* are the difference-maker. In the case of sex development, crawling the causal web accounts for micro-level causal interactions that, *ceteris paribus*, account for higher-level features like testicular development.

Drawing from Mitchell's (2012) theory of scientific emergence and Bedau's (2008) view of weak emergence for natural systems, I put forward that higher-level features of sex development are *multiply realizable*, *causally efficacious* and *explanatorily incompressible* at the microlevel. My proposal is that sex development is weakly emergent in the sense that its macro-level causal interactions are sometimes autonomous from its behaviour at the micro-level. This autonomy exists despite the macro-level features in the developmental process causally depending on genes on chromosomes. As I demonstrated in Chapter III, the process of sex development has lower-level and higher-level determinates, and are thus multiply realizable because higher-level features have causal powers. In the case of testicular development that depends on lower-level XX chromosomes, the causal interactions of the genes on those chromosomes are not the difference-maker for this aspect of sex development. Higher-level features that function as causal difference-makers are efficacious features, i.e., the dependence base, in such cases, does not make the causal difference. In this sort of instance, causal powers at the higher-level are autonomous, which is ground for emergence.

[73] Genes are involved in a variety of local explanations in organismal development, but a gene's-eye-view of sex development.

I propose that sex development is a case of weak emergence because higher-level properties in sex development have causally efficacious but not genuinely new causal powers. The crucial caveat, however, is that the determinates are multiply realizable and causal difference-makers in the developmental process are sometimes at the higher-level. In addition to having multiply realizable and higher-level causally efficacious (and thus autonomous) features, as I discussed in Chapter III, sex development also exhibits dynamism in the form of epigenetic factors circumventing gene action that affect the trajectory of sex development.

In Bedau's (2008) terms, natural systems have micro- and macro-evolutions. These evolutions are changes in the system. Bedau (2008) argues, "Many properties of the emergent patterns are insensitive to the details of the local micro-interactions that produce the patterns, so the emergent patterns have multiple realizations" (449). In short, multiple realizability, causal efficacy and explanatory incompressibility understood as *dynamism* that is not captured by the interactions of the dependence base are conditions for weak emergence. As I've outlined here and in Chapter III, sex development has multiply realized determinates that sometimes exceed gene action, those higher-level determinates are causally efficacious in the developmental process, and an explanation of the causal powers involved in the developmental process is incomplete if the causal interactions of the micro-features are treated as the *only* relevant features.

6.1 Problems for Weak Emergence

Two central worries for weak emergence are parsimony and overdetermination (O'Connor 2020; Wilson 2021). The questions that ontological parsimony raise are as follows: Why posit that there are emergent features or entities on the basis of their causal contributions when such features or entities *depend* on lower-level features? In other words, why not simplify

things and merely privilege causal contributions from the dependence base? An implication of the parsimony problem is that causal contributions at the higher-level are trivial since they depend on the causal goings-on of the base. This worry is related to the problem of overdetermination. The trouble with weak emergence, according to critics like Kim (1993, 1998) is that it entails causal overdetermination. By Kim's lights, since higher-level features synchronically depend on the lower-level there is no sense in holding that these features' powers are distinct. For Kim, the reduction of higher-level powers to base powers is in order. Thus, Kim is in favour of ontological parsimony in the face of overdetermination.

I do not have space to provide a comprehensive discussion of Kim's challenges to emergence and non-reductive physicalism and his critics responses. Drawing on Bedau's and Wilson's responses to these challenges, however, I'll pose two problems with Kim's challenges for weak emergence. In the first instance, in Bedau's terms, accounts of *robust* (i.e., ontological) weak emergence are diachronic and dynamic such that the base features make a causal difference at some earlier evolutions in a natural system, but not necessarily for macro-evolutions or at particular times of macro-evolution. In the second instance, regardless of whether emergent features are diachronic or synchronic, the parsimony solution to the paradox of emergence overlooks that a process, entity or property sometimes has *trivial* dependencies. Dependence base features do not always make a *significant* causal contribution particularly in the evolutions of a process. In thinking of emergence as dynamic, especially in the case of biological phenomena, lower-level features like genetic features in development have a variety of causal roles that are important for particular evolutions of development but also to the overall process. The upshot is that a systems-based (or network-based) model of the causal interactions among properties in a biological process like development (including sex development) is theoretically

preferable to a static linear-hierarchical one, but such an account also sheds light on the mechanisms of sex development and how such a process produces autonomous features that base conditions do not always determine.

7. Sex's Social Properties

I maintained above that strong emergence features a more robust autonomy from the dependence base than weak emergence does. By "more robust autonomy" I mean that strongly emergent features have causal powers that are fundamentally new, whereas weakly emergent features are not. In the case of sex, both genetic (lower-level) and epigenetic (higher-level) factors are capable of causing higher-level features in sex development. Furthermore, as I discussed above, higher-level epigenetic features are capable of silencing the expression of lower-level genetic features—this is not a fundamentally novel power since cells also regulate gene expression, but this higher-level power is causally efficacious nonetheless.

Most theories and criticisms of strong emergence focus on synchronic emergence (Kim 1993, 1999; O'Connor 1994, 2020) however, diachronic emergence also comes in strong forms (Humphreys 2020, 2016; Fan and Zheng 2020). Other emergence theorists, such as Olivier Sartenäer (2015), argue that the distinction between synchronic and diachronic emergence is not a crucial one given that diachronic emergence entails synchronic emergence and vice versa. For my purposes, I do not hold the distinction to be more significant than pointing out that criticisms of strong emergence usually focus on synchronic emergence that take a linear-hierarchical view of lower-level and higher-level causes. A dynamic account of emergence is non-linear, and while it includes supervenient dependencies, such dependence relations do not exhaust the causal landscape for sex and organismal development given that complexity and variation in the causal interactions of biological properties and relations are the standard (rather than the exception) for

biological phenomena. Biological phenomena, due to the nature of evolutionary and developmental processes, which involve networks of relationships between genes and environment, are by definition dynamic rather than static.

I have maintained that the sorts of causal interactions involved in giving rise to sex development are dynamic. The issue I'll address now concerns how sex-based properties are influenced by social properties. One possibility is that sex development is a process so dynamic that it causally forks and obtains social properties at the level of cultural uptake, which are capable of altering sex's hormonal, gonadal, genital and morphological properties. By "level of social uptake," I mean the level of social-cultural interpretation of the properties of sex development. Through social-cultural interpretation, the properties of sex development acquire meanings that are over and above the biological functions of genes, genitals, gonads, and hormones for human organisms. The external genital organs are the properties of sex development that receive the most social uptake in US legal contexts (van Anders et al. 2014). At the same time, genitals, genes, and more recently, hormones have been labelled as definitive of (binary) sex in sport and public policy contexts (van Anders et al. 2017).

In order to illustrate how sex-based properties have parasitic social properties, I'll consider the case of changing one's sex on birth certificates or driver's licences in the United States. In 2014, behavioural neuroendocrinologist Sari van Anders, cultural anthropologist Nicholas L. Caverly, and public health scholar Michelle Marie Johns engaged in an extensive study of the requirements needed to change one's gender/sex[74] on birth certificates and driver's

[74] Van Anders et al. 2014 uses the term 'gender/sex' to "refer to concept that cannot be understood to be either predominantly or only biologically socially constructed" (174). They note that "gender/sex is useful in cases where 'sex' alone might be employed… [it] is a strategic move that troubles the possibility of removing gender from most of what is accorded to sex., while still allowing for the materiality of sex" (174). I refer to 'gender/sex' to denote van Anders et al.'s usage.

licences in the United States. They discovered that changing one's gender/sex on these identification documents is an inordinately complex process that varies from state to state. Notably, while requirements for gender/sex change vary for birth certificates and for driver's licences and vary even more by state,[75] the common feature among most state requirements, approximately 80% of states, was sex reassignment surgery (for birth certificates) or a letter from a medical doctor verifying that one is trans gender (van Anders et al. 2014). Van Anders et al. (2014) argue that the prevalence of surgical or medical declaration of gender/sex as requirements for legal gender/sex change for adults parallels medical declarations of sex at birth, which usually rely on a medical doctor's (cursory) assessment of newborn infant's genitals. Van Anders et al.'s (2014) research presents a key example of how sex assignment is an institutional practice that relies on medical authorities and is typically focused on genitals despite the key role that hormones play in sex development and despite testimony from trans persons about their transition experiences:

> the lack of attention to hormones in legal definitions of gender/sex on US state documents was especially surprising… because of the visibility of hormones in cultural narratives of science as influencing sex-based characterizes. The absent prioritization of hormones was also surprising to all of us because of the primacy of hormones in many transition narratives from trans identified folks, and because hormonal therapies are a widely accepted and sought our component of gender/sex transition processes (van Anders et al. 2014, 184)

The upshot here is that sex assignment and reassignment in the United States are legal conferrals that rely on surgical-medical conferrals, which typically base their conferral on a single property of sex development (van Anders et al. 2014). One might argue that legal conferrals of sex rely on surgical-medical conferrals, which target genitals as the definitive marker *because* genitals play a

[75] Some states require a change on one's birth certificate as a prerequisite for a change of sex on a driver's licence (van Anders et al. 2014, 181).

reproductive role and *who* has *which* reproductive role matters in society. Genitals, however, do not indicate reliably who can bear or seed children as there are many individuals (cis, trans, and nonbinary alike) who lack a reproductive capacity (Ásta 2011). I propose that the target of legal assignments and reassignments of sex is not biological function but is actually (in the sense of covert construction) the assignment of a social role. The fact that some states do not issue a new birth certificate with a new sex assignment, but rather an amended birth certificate that indicates sex assignment at birth and sex reassignment, is, I take it, indicative of this practice *not* tracking a reproductive role, but rather a cis-centred gender role. Having an amended birth certificate, or no avenue for a legal sex change[76], factors into employment discrimination (van Anders et al. 2014). Van Anders et al. (2014) argue that amending birth certificates in this way has far-reaching social consequences for trans persons in terms of "day-to-day life practices and potentials" including employment discrimination and "obviates any privacy that trans-identified individuals may desire about their assigned versus current gender/sex" (180).

Another way to describe how the properties of sex development gain social properties is through the institutional (and wider social) practice of sex assignment, wherein sex-based properties become *gender-coded*. This gender-coding intersects with coding for race, class and sexual orientation to produce social properties and relations that are beyond those of sex development. For a property to be "gender-coded" means that that property has a *gendering* function: it carries feminine or masculine normative expectations. Manne (2017) offers a compelling moral account of how social goods and services are coded along gendered lines where cis men are (typically) entitled to receive feminine-coded goods and services (e.g., domestic labour, care

[76] As of 2022, four states (Montana, Oklahoma, Tennessee, and West Virginia) do not allow residents to change

their legal sex-gender designation (Migdon 2022).

work, emotional labour) and demonstrate masculine-coded goods (e.g., public leadership roles, high earnings).[77]

Drawing on Manne's analysis of misogynistic attitudes and practices functioning as "norm-enforcement mechanisms" for maintaining a patriarchal social order, I suggest that sex-gender assignments function as a norm-enforcement practice for upholding a gendered economy of goods where social goods are coded feminine or masculine along cis lines, and where "violating" one's sex assignment at birth functions as a transgression of this social order that often results in putative consequences (an extraction of social, moral, political and legal goods and resources[78]), especially for trans and nonbinary persons. In Chapter VI, I'll unpack how normative mechanisms i.e., gender terms, attitudes, ideas and expectations attach to the properties of sex development and how intervention through strategic conceptual engineering is needed. In this section, however, I'll focus on social properties.

In Chapter I, I discussed the difference between Ian Hacking's causal construction and Sally Haslanger's constitutive construction. The main difference is that causal construction is a weaker form of social construction that involves a causal feedback loop between classifications, attributions and individuals. Haslanger's constitutive construction, in contrast, is a stronger form

[77] Manne's (2017, 2020) account does not focus primarily on transmisogyny and what "violations" of this gender-coding looks like for trans persons but we can apply her account, along with Talia Mae Bettcher's (2007) account of the normative mechanisms that support transphobic violence, to see that trans persons are especially vulnerable to harms for "violating" their sex assignment at birth and thus binary cis gender-coded way of life. I'll unpack what this "way of life" entails in the following sections of this chapter and in Chapter VI.

[78] For example, prior to the federal legalization of gay marriage in 2015 the United States, having an amended birth certificate that indicated one's new sex assignment alongside one's sex assignment at birth or not being able to obtain a legal sex change in one's state impacted trans persons' ability obtain a marriage licence, and thus legally marry (a legal and social good). As mentioned previously, outing trans persons as trans on amended birth certificates or not having recourse to legally change one's sex also violates the privacy of trans persons to disclose their trans identity as they see fit (a moral good). Moreover, legally requiring a surgical sex reassignment or a medical authorization to change one's sex assignment on official documents also extracts social, moral and political goods from trans persons who do not have the means to acquire sex reassignment surgery and navigate legal and medical systems. This practice also has arguably compounded negative normative consequences for those who do not desire to have sex reassignment surgery because it not only extracts social goods but also reduces gender to sex.

of social construction that depends on the existence of particular social groups and their dynamics. In what follows, I shall put forward that sex-based properties often have parasitic social properties that *causally* constructed.

8. Sex as a Causal Construction

I argued in Section 3 that sex lacks constitutive social properties. Here I propose that sex acquires social properties and relations when the properties of sex development are labelled in social contexts. Such labels are more than mere tags and are accompanied with the classifications *female* and *male*, which usually serve a gendering function in social contexts. I'll unpack how these labels serve a gendering function further in Chapter VI, but suffice to say a gendering function is a gender assignment targeted at habituating one into a binary cis gender role (akin to Manne's account of feminine- and masculine-coding), which is *more* than a conferral. Notably, my account of sex goes beyond Astá's view that sex is not biological, but rather is a one-time institutional conferral. What I'll argue below is that sex is biological in a constitutive sense, but is biological *and* social in a causal sense.

My account is similar to Ásta's (2011, 2018) conferralist account of sex and to Judith Butler's (1993) account of sex as acquiring meaning within a gender matrix in the sense that I agree that sex serves social purposes (has a gendering function) in social contexts. The main point of departure, however, between my account and Ásta's and Butler's is that I go a step further and claim that sex *is* biological while also providing an account of why and how it is biological, rather than claiming that there is *something* that exists prior to conferral, in Ásta's (2010, 2018) case, or that sex is materialized via regulatory gender norms, as in Butler's (1993) case. To reiterate, Ásta's and Butler's accounts of sex do *significant* work in unpacking how sex's social properties are covertly socially constructed, but my contribution to this literature

points out that this construction is causal not constitutive. Moreover, my contribution aims to further unpack what this "something" that exists prior to conferral is in order to assess whether and how demystifying sex as biological can do ameliorative work.

More than a conferral and more than discursive, in Chapter VI I shall argue that sex assignments at birth have a gendering function that is a type of faith-based initiation process. My claim will be that declaring sex at birth is more than a legal, medical or institutional conferral, it is, instead, a type of 'baptism' into a way of life—a faith-based commitment to a cis gender binary that is underwritten by an economy of goods. I'll focus on sex labels and conceptual engineering in the next chapter, but my task here is to unpack how sex's causal powers operate in social contexts.

Sex development is variable on its own as I have discussed in Chapters II and III, but its properties can also change via surgeries and interactions with social-environmental conditions such as endocrine disrupters (Piazza and Urbanetz 2019). In short, the properties of sex development change over time via natural processes such as puberty and menopause, but also via social and environmental factors that range from contraceptive methods, surgeries and hormonal therapies and hormonal changes due to environment. I suggest that such changes to the properties of sex development are common and various, but that some of these changes are causally efficacious in ways not held by lower-level features[79] of sex development. Such causally efficacious social features can also change some sex-based features, e.g., hormonal and morphological changes. Sex assignments have a gendering function, so much so that *gender* is often demarcated as *female* or *male* in a variety of institutional contexts. The labels *female* and *male* often function as a shorthand for categorizing human individuals as a cis woman or a cis

[79]This includes features at the lowest-level: genes on chromosomes.

man. This is more than a legal, medical, or institutional conferral because the label helps create an expectation for who an individual *can be* within their social setting, but also for the individual themselves (whose gender identity might conflict in a variety of ways with the gender attitudes connoted with the label) (Bettcher 2007; Butler 1990, 1993, 2004). In this way, sex assignments function to not merely interpret an individual within a social matrix, but initiate one into a doctrinal *way of life* (or attempt to secure a cis gendered future) (Clune-Taylor 2019).

As I discussed above, sex conferrals are only one aspect of sex's social properties. Sex assignments are not only an *external* imposition, but importantly, sex assignments also come with an *internal* set of commitments for how one identifies and acts in a social context. This network of relations between the labels *female* and *male*, the gendered expectations that connote those labels, and an individual's inner life illustrate a type of causal interaction that the properties of sex development alone do not account for. The reason for this is that social interpretations of bodies, arguably, involve causal powers that are distinctly autonomous from the properties of sex development. As I mentioned above, I'll leave the question of how or whether these social properties are strongly emergent to the side, but the social and moral harms that sex assignment practices create are far beyond the causal capacities of sex-based properties.

9. Sex as a Biological Kind

I have argued above that sex is biologically and socially caused but only biologically constituted. Sex assignments are implicated in a variety of human social and social-psychological phenomena, which go beyond biological classifications *and* beyond sex classification schemes for other animals. For these reasons, I offer that sex is a biological kind. As I maintained in Chapter II, causal looping is a central feature of socially significant biological kinds where social properties can alter biological properties and vice versa, which renders

biological kinds malleable. I also described the causal interactions of biological kinds as operating in a similar manner as Hacking's interactive kinds, but noted that a difference between his notion of an interactive kind and my notion of a biological kind is that the latter does not necessarily involve an individual's self-awareness in relation to a label or classification.

In short, I have put forward that sex is a biological kind because it is constituted by the biological properties of sex development, and sex development is a dynamic emergent process. Genetic, hormonal, environmental, social-political and personal factors have the potential to *causally* influence someone's sex in a myriad of ways but those properties are *constitutively* biological. In so doing, I hope to have contributed to demystifing the often gender- biased claim that sex has a "biological reality," by showing that sex's biological properties do not do the normative work gender stereotyped attitudes purport it to do.

In theorizing sex as a biological kind, I aim to show that although it can be difficult to untangle sex's biological constituents and its biological and social causes in practice, this work *can* and *should* be done in order to further rectify normative claims about the "biological reality" of sex (and gender). The properties of sex development are not instructive for the normative question of how we should live our lives. They do not, on their own, provide a set of gender instructions. A central aim of my account is to take a step back from the various entanglements of sex and gender to see what might be possible if we were to abandon imbuing sex-based properties with gender stereotypes.

8. Conclusion

K. Anthony Appiah (1985) observes, "The truth is that there are no races: there is nothing in the world that can do all we ask 'race' to do for us" (35). About sex, my proposal is that the properties of sex development cannot do all we ask sex to do for us—whether

that is via sex assignment practices at birth or legal requirements for trans persons to change sex surgically. My account of sex diverges from Appiah's account of race in the sense that I am not an eliminativist about sex-based *properties* but I do wish to eliminate SEX concepts that are anchored in 'gender faith' or based on a set of cis gender commitments.[80] Sex assignments are not biological—they are social, and they do *not* guarantee that someone will be anchored into a cis gendered way of life but are an initiation into a type of 'gender faith' (a set of cis gender commitments) that labellers often hope will stick.

In this chapter, with the help of *Sex on a Desert Island*, I argued that sex and gender can be decoupled via strategic technologies. I'll explore one such 'technology' in the next chapter, when I present my account of strategic conceptual engineering. Here, I also put forward that sex is biologically constituted and caused but only socially caused. I maintained that sex is a biological kind because its constitutive properties are the biological properties of sex development. And I argued that sex development is a dynamic emergent process that is not responsible for the social practice of sex assignments, rather normative commitments are responsible for the practice of sex assignments as we know them. In the following chapter, I'll argue that a compelling feature of sex as a socially significant biological kind is that its social causes are alterable. My approach shall be to advocate to restrict sex's social properties through utilizing a novel concept of sex, the nonbaptismal sex concept, for normative aims.

[80] These commitments include relevant demonstrations of traditionally feminine- and masculine-coded goods and services.

Chapter VI: Nonbaptismal Sex

1. Introduction

In this chapter, I offer my new concept of sex, which I call the *nonbaptismal* sex concept. Nonbaptismal sex is a deflationary concept geared to meet epistemic, social and moral aims. Using notions of *baptism* and *faith* metaphorically, I hope to shed light on the gender-coding that underlies prevailing sex assignment practices. In order to do this, I'll make use of van Anders' (2014) notion of bio/logics and contend that contemporary sex assignment practices function as the entry point into a cis gendered future. I'll argue that these futures entail a generally bifurcated economy of social goods and services.

In Chapter V, I explained that although sex and gender are ontologically distinct in the sense that sex is biologically constituted while gender is socially constituted, at the level of social-cultural interpretation, sex-based properties become gender-coded. This gender-coding enables sex-based properties to have social causes that go beyond reproductive function. I also explained that gender-coding has a gendering (ordering) function, which targets habituating individuals into a binary gender role. In what follows, I'll emphasize that such gender habituation begins with sex assignments, which, contra Ásta (2011, 2018), are more than a one- time conferral.

Even though I endorse the sex/gender distinction, it is crucial for me to acknowledge how sex and gender are conceptually conflated in everyday thought and talk as well how their conflation is embedded in our social and legal structures—so much so that it can be difficult to imagine otherwise. This chapter deals specifically with the notion of *sex baptism* (rather than gender baptism) because I want to show how past and current SEX concepts have an asymmetrical significance that is not shared with our gender concepts. Unlike gender, sex tends

to be thought and talked about as a natural or material foundation for (binary cis) gender roles. This broad-scale interpretation of sex, in Butler's terms, as the "originary material" for gender norms (1993, xii-xv) marks the asymmetry with our prevailing thought and talk about gender. My account rejects the tenet that sex is (in actuality) the basis for gender norms, but at the same time, I believe it is worthwhile to elucidate sex's social features so that we may interact with them more responsibly.

I am spoiled for choice when it comes to contemporary examples of consequential 'faith-based' attitudes towards sex and gender, but in this chapter I'll highlight how the current wave of anti-trans legislation in the United States, and the political framing of reproductive health care as only a women's issue, are instances of powerful institutional enactments of gender faith. Building on my brief discussion of sex assignments and gender faith in Chapter V, I'll argue that the dominant concept of sex embedded in case and statutory law[81] and authorized in medical practice is a baptismal concept, which at its most sophisticated, incorporates a layer cake causal story of how sex is related to gender, but at its core is a concept that functions to regulate social and moral goods. My novel concept is strategically developed to counter moral and social-political gatekeeping related to gender. I'll argue that utilizing the nonbaptismal sex concept is necessary but not sufficient to meeting this aim, since concepts alone do not change the material conditions of those oppressed on the basis of gender.

1. Sex Baptism: Examples from Case Law and State Legislation

Utilizing Sari van Anders' (2014) notion of "bio/logics (B/L)," which she defines as "implicit and/or explicit reasoning guides informed by features thought to be natural, corporeal, evolved, and material," I'll unpack how sex assignments at birth function as a sort of baptismal

[81] The scope of my analysis will be limited to examples from the US and UK.

practice into a cis gendered way of life. This 'way of life' employs multiple directives (or bio/logics) putatively based on sex. She argues that bio/logics "locate gender/sex in one true natural form that can only be authenticated by others. Identifying different types of B/L highlight the cultural situatedness of even biologic sex" (2014, 33). The three types of B/L she identifies are "interior bio/logics (iB/L)," "newborn bio/logics (nB/L)," and "trace bio/logics (tB/L)" (2014, 33-34).

Interior bio/logics, according to van Anders (2014), refer to a "hierarchy in which the most essential features of gender/sex are seen to be the most biologic, and the most biologic are the most *interior*: the most deeply embedded in the body and the least changeable or malleable (33).[82] She points out that although genes, gonads, genitals, hair and nails are all bodily features, iB/L is a foundation for legal definitions of gender/sex in case law. For example, the ruling in *Corbett v. Corbett (otherwise Ashley)* appealed to chromosomal sex as the "true" marker of sex among gonads, genitals, hormones, and psychology as other factors (*Corbett v. Corbett* 1970). In this UK case, Arthur Cameron Corbett sought an annulment from his wife, April Ashley, a trans woman, on the grounds that Ashley had been "a person of the male sex" at the time of their marriage. The judge, Lord Justice Roger Ormrod, ruled in Corbett's favour citing Ashley's chromosomal sex as the basis for granting the annulment. For his decision, Ormrod's stated reasoning was that marriage is between a man and woman and Ashley had a male chromosomal sex at the time of marriage. This was Ormrod's ruling despite Ashley's testimony that she had a female sex at the time of marriage. Ashley also went through an extensive examinations by medical authorities in order to 'establish' her sex for purposes of the trial. Despite being declared

[82] Baron-Cohen's (2003) and Brizendine's (2006, 2010) views can be understood as interior bio/logics since they both view sex development from a gene's-eye perspective *and* postulate that chromosomal sex are responsible for gender-based behaviours.

"intersex" (rather than trans) by the team of medical authorities consulted for the trial, Ormrod ruled that having XY chromosomes (along with *having had* testes and a penis) meant that one was legally male (*Corbett v. Corbett* 1970). He ruled as follows:

> It is common ground between all the medical witnesses that the biological sexual constitution of an individual is fixed at birth (at the latest), and cannot be changed, either by the natural development of organs of the opposite sex, or by medical or surgical means. The respondent's operation, therefore, cannot affect her true sex. The only cases where the term 'change of sex' is appropriate are those in which a mistake as to sex is made at birth and subsequently revealed by further medical investigation (*Corbett v. Corbett* 1970).

This UK case and US cases such as *Littleton v. Prange*[83] reflect interior and trace bio/logics as well as a conflation of sex and gender. It is clear that marking XY chromosomes as definitive of sex-gender is an interior bio/logic since it is the single feature that Ormrod took to represent Ashley's so-called "true sex." Interior bio/logics generally do not accommodate legal recognition of gender or sex transitions. The case reflects trace bio/logics in the sense that genes and gonads are privileged as determinants or "starting points" of sex and gender (van Anders 2014). With trace bio/logics, gonads and genitals are assumed to leave 'traces' or to always be present even when they are absent. Van Anders (2014) points out that these traces may be *material*, e.g., the trace effects of hormones released from gonads) or *conceptual*, in the sense that "born-penises" and "born-vaginas" (but never mind "born-vulvas") are meant to function in heterosexual couplings (van Anders 2014; Stirnitzke 2011). The use of trace bio/logics may indicate why some US states *amend*, rather than replace, sex on birth certificates (van Anders et al. 2014).

[83] In *Littleton v. Prange* (1999) a Texas judge voided the marriage between Christie Lee Littleton and Jonathan Littleton. Chief Justice Phil Hardberger ruled that the Littleton's marriage was invalid because Christie Littleton, a trans woman, had XY chromosomes, testicles, and a penis at birth. He argued that biological factors were preferable over psychological factors in determining sex, and used *Corbett v. Corbett (otherwise Ashley)* as precedent (*Littleton v. Prange 1999*).

Newborn bio/logics offer a different directive, rather than being interior, sex is exterior and easily identifiable by medical authorities at birth. In van Anders' (2014) terms, newborn bio/logics serve to "naturalize" sex assignments at birth but also to "renaturalize" sex assignments for transitions through relying on medical authorities to engage in surgical modification of genitals or to otherwise certify a sex change based on the appearance of sex-based properties (Currah and Moore 2009; van Anders et al. 2014). As of 2020, a majority of US states require a medical authorization to support a legal sex change (including but not limited to surgery). Tennessee is the only state that prohibits sex change on birth certificates (Lamda Legal 2022). Even though the majority of states still require medical authorization for legally changing sex, there is a growing number of states with more inclusive criteria (where self-declaration, authorization from a therapist, and/or hormone treatments meet legal criteria). And more states offer a third option for sex on driver's licences (Lamda Legal 2022). In the past eight years, there has also been a shift in case law, including in Texas, towards treating sex change as legal sex assignment (*Estate of Araguz* 2014).

There has been an wave of anti-trans legislation in the US in 2021 and 2022. The most recent bills target trans youth. 2022 has seen a record number of bills proposed (140 in 36 states and counting). Bills would prevent trans youth from accessing gender-affirming health care, playing competitive sports, or using bathrooms that correspond with their gender identity. Bans on competitive sports have been implemented in four states (AZ, IA, SD, and UT), and those banning the teaching of topics related to gender identity and sexual orientation have been passed in Alabama and Florida (ACLU). Studies indicate that receiving gender-affirming health care[84]

[84] Gender affirming health care ranges from prepubertal children talking with pediatricians and therapists about their gender identity, pubertal children receiving 'puberty blockers' to delay later stages of puberty, and/or teenagers 16 and over receiving hormone treatments or having the possibility of top surgery for transmasculine youth. Cis gender youth sometimes receive puberty blockers to delay early puberty (Boerner 2022).

lowers rates of suicide, depression and self-harm in trans and gender diverse youth and adults (Boerner 2022; *The Lancet* 2021; Sorbara et al. 2020; Tordoff et al. 2022). Interior bio/logics appear relevant to these recent statutory examples as well. A number of bills appeal to "biological sex" as definitive of who someone is and what they should *not* be allowed to do (ACLU; *Kentucky* HB 23, SB 23; *Alabama* HB 23; *Tennessee* SB 1861).

I suggest, however, that the appeal to "biological sex" as revealing the "true" gender of trans youth (and thus the "true" gender of every individual) targets people's access to social goods and services, viz., school sports participation, which generally is beneficial to students[85], access to public facilities and access to health care resources that enable flourishing in terms of a sense of belonging, safety and security, a self-esteem, and self-understanding among others (Boerner 2022).

Along similar lines, the impacts on access to goods and services this current wave of anti-trans legislation are akin to those targeted in case law examples. In *Corbett v. Corbett* (*otherwise Ashley*), *Littleton v. Prange*, and *Estate of Araguz*, economic goods were at stake.[86] The trans women involved in each of these cases stood to gain financial support, damages, or an inheritance based on their respective marriages to cis men. As a consequence, the legality of their marriages was called into question by the complainants who challenged the legality of their marriages on the basis of sex. I offer that although each judge's decision was presented as an epistemic matter of interpreting 'bodily facts' to establish sex as a legal concept (or to re-establish it through applications of precedent), the medicalization of sex used to adjudicate these decisions had moral and social-political targets and impacts. Van Anders' (2014) analysis of

[85] School sports are shown to help students build self-confidence, self-understanding, cooperative relationships, enrich one's capacity for empathy, and nourish one's physical and psychological well-being (Amaro 2020).
[86] In *Corbett v. Corbett (otherwise Ashley)*, Ashley sued her husband for financial support, in *Littleton v. Prange*, Littleton sued Prange for damages, and in *Estate of Araguz*, Araguz was set to inherit money from her late husband.

bio/logics is useful for shedding light on the variety of ways sex is medicalized in law—even in less (socially) conservative decisions such as *Estate of Araguz*. Medically authorized declarations of sex, whether they are required at birth or at transition, wield some social and political power away from an individual in terms of their gender self-identification and how that self-identification is embodied. Most legal conceptualizations of sex, which usually conflate sex and gender and tend to involve internal, trace, or newborn bio/logics[87], have binary extensions: one is medically assigned *female* or *male*.

In Chapter V, I claimed that sex assignments are more than a one-time conferral and more than a cultural norm disguised as part of the law. I shall maintain in what follows that although sex assignments *are* partly a conferral and social-cultural norm, they are also part of a collective leap of faith into a gendered economy of social goods[88]. This leap of faith is instrumental to adjudicating feminine- and masculine-coded goods. Social goods include public spaces (e.g., washrooms), social institutions (e.g., marriage), participation in associations (e.g., sports teams) and services (e.g., health care). These are only a few of the goods that come with being coded as a (cis) woman or man. Feminine-coded goods include tangible goods such as having and raising children, domestic labour, other forms of care/giving labour, and emotional and social labour such as giving love, sex, attention, respect, and admiration (Manne 2017). Masculine-coded goods, in contrast, typically come with more social-political leverage such as leadership, authority, money, and other forms of influence like prestige (Manne 2017). When boundaries are broken, especially when (cis) women seek masculine-coded goods, this can result in various forms of social punishment for (cis) women (Manne 2017). Using Manne's (2017)

[87] The Gender Recognition Act (2004) in the UK and more inclusive criteria for changing sex (e.g., documentation from a therapist, hormone treatments or declaration of gender self-identification) in some US states move away from newborn bio/logics.
[88] A gender economy of binary feminine- and masculine-coded goods.

ameliorative framework, I'd like to suggest that social punishments for violating the bounds gender-coding impact everyone including cis men, trans and nonbinary individuals.

Social punishment serves as a mechanism to keep with the faith. I offer that a key reason why violating gender-coding results in social punishments is because it amounts to a violation of faith—not just a violation of binary gender norms. What is the difference? The difference between a social norm and a faith is that the former involves informal social rules that govern behaviour in social groups and societies, whereas faith concerns a strong belief or trust in something or someone (Bicchieri et al. 2018; Kelly and Stetman 2020).

Gendering-coding, on my analysis, involves rule-following but also an explicit or implicit belief, trust or commitment in/to the rules. What is significant about these commitments is they support gender rule-following in a way that goes beyond individual fears of social consequences for norm violations, and towards a collective enabling of the rules that is based in *aspirational* attitudes about what is morally good for women and girls or men and boys. What I'm suggesting here is that more than rule-following, binary gender norms are aspirations toward putatively good lives. And sex assignments are initiations, or *baptisms*, into the faith.

Not everyone, however, 'keeps the faith,' and gender-biased laws and policies, along with other forms of social punishment, attempt to restore the collective system of gender-based beliefs and practices akin to how religious faith involves an *internalized* adherence to organized systems of doctrines and ceremonies. With this analogy, I am not implying that what I'm calling 'gender faith' is equivalent to monotheistic religious faith. What I am suggesting is that the dominant attitudes, norms and practices of binary sex-gender mimic some of the features of religious faith—particularly an orientation of belief toward a big-picture worldview (rather than a mere acceptance of rules or teachings).

2. Sex Baptism: Gender Reveal Parties as Faith-Based

To be tongue-in-cheek for a moment, let's consider how the contemporary practice of gender reveal parties illustrates sex-gender as a matter of gender faith. Gender reveal parties rose to popularity in the 2010s in most Western English-speaking countries and in Puerto Rico with the help of social media platforms. A gender reveal party involves future parents inviting friends and family members to a gathering where the 'gender' of their unborn child is 'revealed'—usually through cutting a cake that is either pink (for a girl) or blue (for a boy) on the inside, popping balloons that are stuffed with pink or blue confetti, firing pink or blue pyrotechnics (and sometimes starting massive wildfires), or even dumping hundreds of gallons of pink water from an aircraft.[89] Aside from the silliness of such events, gender reveal parties not only reinforce binary gender stereotypes (some cakes are decorated in frosting that asks questions like: "Guns or Glitter?", "Rifles or Ruffles?", "Stashes or Lashes?", and "Pistols or Pearls?"), but make the category mistake of conflating[90] sex with gender.[91] The basis upon which the 'gender' of a fetus is 'revealed' is the genital development detected with ultrasound imaging in pregnancy. Ultrasound detection is usually but not always accurate, and sometimes the development of a penis is overpredicted. The important issue to note here is not only do such practices confuse a penis with a gender (i.e., where the detection of a developing penis is taken to indicate that one *is*

[89] In September 2020, the pyrotechnic device used at gender reveal party that was meant to "reveal" the gender of a fetus ignited the El Dorado wildfire in California killing one person. The El Dorado Fire was not the first time gender reveal parties ignited massive wildfires, resulted in fatalities, or caused explosions. The 2021 Fort McMurray wildfire, the 2017 Sawmill Fire in Arizona, the 2019 Iowa pipe bomb, the 2019 Texas plane crash, and the 2019 car explosion on Australia's Gold Coast are a few examples of how gender reveal parties have saturated some societies to severe but unintended consequences.
https://www.cbc.ca/news/canada/edmonton/fort-mcmurray-wildfire-gender-reveal-exploding-target-1.6057570
https://www.nytimes.com/2020/09/07/us/gender-reveal-party-wildfire.html

[90] Many, but not all, feminist theorists and scientists maintain that there is a distinction between sex and gender. The traditional view is that there is no distinction, rather gender is equivalent with sex.

[91] Bologna, Caroline. (2018, August 16/2019, June 25). "How Gender Reveals Became Such a Thing: Exploring the History, Popularity, and Criticism of this Pregnancy Trend." *Huffington Post*.

a boy *and* thus will prefer guns to glitter), gender reveal parties inscribe gender stereotypes onto sex. In turn, such gender-coding places restrictions on what having a penis means for an individual in ways that move far beyond reproductive function. To "reveal" the gender of an individual *before* their birth is to assume that gender is a feature of an individual that they have no say in—to the extent that their beliefs about themselves and their experiences are not held as primary influences in gender identity.

One might claim, however, that the practice of gender reveal parties is harmless[92] fun—of course most parents know that the seeming presence or absence of a penis does not determine what gender identity an individual will have in the future. Even in this best case scenario, however, (where the intentions of adult participants is not to assume that sex instantiates binary gender stereotypes), practices influence how sex-gender is socially constructed because practices are replicated and often done so uncritically. Those who encounter this practice on social media or offline might come to internalize these stereotypes and their inscription onto sex-based properties like genitals, which can have the effect of reenforcing the baptism. The upshot is that the sex baptism (whether it comes in the conspicuous form of a gender reveal party or the gifting of a baby doll to a girl child) is not biological—it is social. This practice is a social practice because it is informed by gender expectations and is an initiation into a prescribed social role that uses human bodies as markers for the initiation. My contention is that sex baptism is the linchpin practice that biologizes and binarizes gender, which then goes on to be reinforced by various other gender practices over a person's lifetime.

Another example of how sex baptism functions concerns binary assumptions about behavioural properties that conflate sex-gender. Conflations of sex-based and gender-based

[92] Sadly, the loss of life, wildfires, explosions, and plane crashes that have occurred recently in the process of "revealing" the "gender" of fetuses are immediate and conspicuous harms.

properties in case law can be seen in Ormrod's descriptions of Ashley's femininity in *Corbett v. Corbett (otherwise Ashley).* Such conflations are sometimes used to dismiss a person's gender identity or gender presentation on the basis that sex-based properties (whether "interior" or "trace") are the "true" representations of gender regardless of self-identification or behaviour. The reason for this is that sex baptism attributes a behavioural repertoire to putative reproductive roles and activities like purported (*female*) *caregiving* and *intimacy seeking* versus (*male*) *aggression* and *hypersexuality*. These attributions support a gendered economy of goods—goods that one shall give or receive if they are faithful.

Taking a step back from the principles of gender faith, these behaviours are not obviously sex-based because although hormonal changes *can* cause changes in behaviour there is not sufficient evidence that hormones influence alterations in behaviour as frequently as behaviour influences changes in hormones (Carré and Archer 2017; Hines 2004; Jordan-Young 2010; van Anders et al. 2013; 2015, 2017; van Anders and Watson 2006). As discussed in Chapters III and IV, there is no one–one relationship (let alone an asymmetrical one) between the hormonal effects of e.g., testosterone and estradiol and particular behaviours. Biobehavioural properties are multiply realized in the sense that environmental stimuli (like a social expectation of masculine dominance) can give rise to changes in behaviour to produce a joint effect with the hormonal change (e.g., a rise in adrenalin and cortisol)[93]. The point here is that sex-based properties can influence but do not uniquely determine social behaviour yet this notion saturates sex as a baptismal practice into gender faith. The new sex concept I purpose, the *nonbaptismal* sex concept, purposefully rejects sex baptism as a way to demarcate sex with the hope of breaking the faith in tangible ways.

[93] Adrenalin and cortisol are not (what I label) 'sex-based' properties on the layer cake model even though they play a role in behaviours that are associated with sex, in particular, *male* behaviours.

3. Nonbaptismal Sex

I stated at the start of this chapter that I do not expect my conceptual engineering approach to change the material conditions of all persons negatively impacted by oppressive attitudes and practices related to sex-gender. Ameliorative projects are not a universal solution to gender-based discrimination and disempowerment, which occurs along intersecting dimensions of oppression and in a variety of social-political and personal contexts. What changing concepts *can* do, however, is change social attitudes over time, and changing social attitudes can influence changes in law and policy (Pachankis et al. 2021; Podosky 2018, 2021; Sterken 2020). In fact, multiple meta-analyses show that a decrease in "structural stigma," where structural stigma is understood as "labeling, stereotyping, status loss, and discrimination exist within a context of unequal power" (Pachankis et al. 2021) has contributed to lower rates of suicide and depression among gay, queer and bisexual men (Bromberg et al. 2020; King et al. 2008; Ross et al. 2018). These meta-analyses are significant because they show how labels and stereotypes present in law and other sites of institutional power impact mental health (Pachankis et al. 2021).

My ameliorative project is strategic in the sense that it aims to restrict the contexts in which sex is invoked. In what follows I'll offer a deflationary concept of sex that has the strategic aim of minimizing or eliminating our use of *female* and *male* in most social contexts (e.g., legal, educational, occupational, housing, and so on). My hope is that adopting a nonbaptismal concept of sex in institutional and social contexts will remove the use of bio/logics in those contexts. Minimizing sex in legal and other institutional contexts has the potential for broader-scale social impacts that are enabling, e.g., in terms of countering gender-based discrimination that appeals to

putative sex differences and in terms of assigning legal rights and gender-appropriate social recognition.

Ameliorative projects necessitate that we make active decisions about what the words we use mean (Jones 2014; Manne 2017). In describing ameliorative projects, philosopher Kate Manne (2017) makes this point succinctly: "…if we want to change the world, we may need to conceptualize it differently" (42). If, as feminists or as a society, we want sex classifications that are just, we need to take a hard look at the biology of sex and reimagine our sex concepts in ways that best fit the science *and* morally and politically just social goals and practices.

Human beings are social animals, and because of this, we are susceptible to conforming our practices to those social norms and beliefs that are preserved by our basic concepts, categories, and schemas. In other words, if we are to change our institutions' practices, it is necessary to change our concepts. We can change our concepts for both scientific and social-political reasons; and in the case of sex, both types of reason are necessary (but not sufficient) for constructive change. Furthermore, as social animals—we humans have a problematic tendency to enforce social norms and expectations uncritically, and sometimes unscrupulously, in order to preserve (our ideas about) the order of things. Ameliorative projects are important because not only do they force us to make clear what our current concepts are and their accompanying pitfalls or strengths, ameliorative projects also require us to scrutinize our goals and to think critically about what we want our words to mean. This latter feature makes ameliorative projects partly stipulative, but this does not (or ought not) mean that they are arbitrary in nature (Manne 2017).

In the case of sex, it *seems* fairly straightforward that we would want our concept(s) of sex to match our best scientific knowledge, which would involve engineering a concept that allows for a spectrum of sex-based properties. The above *seems* straightforward unless one has

epistemically unwarranted or gender-biased reasons for opposing a sex concept that fits empirically adequate findings on variability in sex development, and that is in line with social justice aims for people of all genders. To date, an ameliorative SEX concept that combines empirical and normative considerations has not been offered in feminist philosophy.[94] Offering such a concept can help strengthen feminist arguments for social justice in light of bio/logical laws and policies.

Concepts of SEX that make use of bio/logics, whether they are embedded in legal, medical[95], or educational institutions, are baptismal sex concepts. This includes the linear-hierarchical notion of sex I discussed in Chapters III and IV and its folk cousins. A human body, a body part, or an individual is not merely labelled, but *baptized*[96] female or male at birth (and increasingly *before* birth at gender reveal parties). This baptism as female or male is a *social practice*. Baptism, after all, is a social affair, which is an initiation into a particular *social role* or suite of activities. If someone is adjudged male at birth (or before birth) this declaration involves more than a label but also involves a substantial array of social expectations—including sociosexual and other behavioural expectations, many of which are very narrowly construed.[97]

According to Haslanger (2018), social practices are sites where individual agency enables or constrains, where (material and non-material) goods are created and shared (or not), and

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[94] Feminist philosophers Monique Wittig (1982) and Judith Butler drawing on Wittig (1990, 1993) provide compelling arguments against the sex/gender distinction that deflate a separate concept of sex. Feminist science studies scholars Anne Fausto-Sterling (2000a), Rebecca Jordan-Young (2010), and Sarah S. Richardson (2013) help to clarify the biology of sex and the ways that sex is gendered in scientific practice. Richardson (2013) offers a concept of sex as a dynamic dyadic kind, but it does not address social-political aims (199).

[95] Van Anders et al. (2014) offer that, in addition to the legal system, bioscience and medicine have helped define, regulate, and shape our common understanding gender/sex. Surgical-medical authorizations of sex classifications, the decision-making that leads to 'corrective' surgeries on intersex children to match binary sex-gender schema (Butler 1993, 2004), and differential treatment of persons in clinical and medical research settings based on sex that has negative impacts on health, usually, for cis women (Schiebinger 2003).

[96] My notion of sex baptism is not directly related to Saul Kripke's (1980) idea of baptism via naming in his causal picture of reference.

[97] Some sociosexual and other behavioural expectations are that males are hypersexual, aggressive, risk-taking, and logical or systematizing thinkers (Baron-Cohen 2003; Fine 2010, 2017; Richardson 2013).

where there is a potential for social change given that such practices are in a sense 'up to' human beings. If sex baptism is a social practice that assigns gender-coded goods to persons based on *ad hoc* institutional assessments of bodily properties, *but* social practices (even deeply embedded ones) are alterable, then we can stop engaging in this covertly normative endeavour. As I argued in Chapter V, legal sex assignments (and reassignments that mimic the former) are institutional practices that rely on medical authorities for their putative legitimacy. Such assignments are a standard case of covert social construction given that they are purportedly descriptive, but are actually prescriptive and proscriptive. Based in bio/logics, sex assignment practices do not simply point out 'the facts' about human bodies, but are initiations into a way of life—of goods owed and goods forbidden.

My nonbaptismal SEX concept aims to minimize the import of sex's social properties, particularly its baptismal properties, while foregrounding that sex-based properties are diverse. In doing so, my account leaves room for one to associate their gender-identification with an identification with some sex-based properties or none at all. For my nonbaptismal sex concept, the properties of sex development are relevant to many biomedical and research contexts for purposes of therapeutic care and clinical trials (Schiebinger and Klinge 2018; Schiebinger 2021).

Philosopher and legal scholar Anita L. Allen (forthcoming) argues that philosophers engage in what she calls "analytic definitional prescription," which occurs when philosophers specify a particular definition, of e.g., privacy, for a particular purpose. For Allen, these types of analytic prescriptions are usually too narrow to accommodate the ways ordinary speakers refer to concepts like privacy. Allen proposes "critical definitional facilitation" as an alternative, which focuses on the definitional significance of speakers' usage of concepts and terms—particularly as that usage reflects speakers' interests and their moral or legal rights. Allen's criticisms of

analytic definitional prescriptions are worth taking into account as part of a conceptual engineering project. After all, it does little good to put forward a concept that does negligible work for those most impacted by how particular words and ideas are used. At the same time, it is worth noting that words and ideas can have broad and contradictory meanings across communities and individuals. As with other concepts and terms that bear significantly on people's lives, in my estimation, it is important to tread carefully with sex—to not offer a concept that is too restrictive but also one that is not too pluralistic such that anything goes. My hope for finding a middle-way between overly restrictive or overly pluralistic approaches leads me to incorporate an option for self-identification with a sex-based property (or properties) on my nonbaptismal sex concept.

To take stock, I have outlined the nonbaptismal SEX is deflationary in the sense that it incorporates my metaphysical analysis that sex is constituted of nothing over and above the properties of sex development and that sex's social properties, in practice, are generally restrictive but alterable. My approach to strategically intervening in these social properties is by foregrounding sex's biological properties and mitigating their social significance (to be closer to the significance of blood type). I've highlighted that legal and surgical-medical aggregations of sex-based properties as female or male is a social phenomenon, which is typically integral to demarcating gender-based social roles. Since legal sex assignments serve a social function, my suggestion is to forego legal *sex* assignments. And replace them with legal options that allow for nonbinary and agender identifications, but also enable changing legal gender in ways that rely on self-identification, rather than conferrals by surgical-medical authorities.

If the aim of the nonbaptismal sex concept is to acknowledge that sex assignments and reassignments are *social*, and that the properties of sex development on their own do not do the

moralizing work, then why is self-identification with a sex-based property or properties incorporated in the concept? I believe it is important to acknowledge the embodied relationship that many individuals have with their experience of gender. For some, having particular sex-based properties does not matter much to how they present or experience their gender, but for others, it does. What I want to do is accommodate both sorts of cases: where individuals talk about their sex-based properties in ways that are meaningful to their gender identity, and cases where a person's sex-based properties do not bear significantly on their gender identity.

My goal for incorporating an option for self-identification with sex-based properties or none at all would enable speakers to communicate meaningfully about their sex-based properties and gender, without, in principle, the use of bio/logics. The nonbaptismal sex concept supports individuals' identifications with their sex-based properties (or not) without institutionalizing sex. The moral aim is to divorce sex from pre- and proscriptive gendered ways of life while honouring persons' contentment with, desires to change or desires to ignore their sex-based properties within a wider social context where sex-based properties matter less. In this way, I have tried to strike a balance between overly restrictive analytic prescription and an overly pluralistic focus on speakers' uses, which further runs the risk of affirming bio/logics.

The political aim of my new concept is to fully recognize the dignity and intelligibility of all persons with sex-based properties (i.e., everyone) in a way that is decoupled from gender prescriptions and proscriptions and supporting bio/logics. My hope is that applying a nonbaptismal SEX concept would make room for a broad adoption of pluralistic and trans-inclusive GENDER concepts.

4. 'Getting Sex Right'

I've presented my nonbaptismal sex concept, but how does it fit with my view that sex is a biological kind? Does the former require the latter? The short answer is yes. Ideally, we should have a sense of *what* we are conceptually deflating and *how*—what are the relevant constraints, and what legitimizes the use of the concept over others? As I explained in Chapter II, a concept that works fulfills its function as a representational vehicle for a specific target. Just as in scientific cases, e.g., where the appearance of molecular genetics gave way to the molecular gene concept, so should a deflationary metaphysics of sex make way for a deflationary sex concept. What sets my deflationary account apart from others, such as Butler's and Àsta's, is that I consult contemporary research in the biology of sex. Specifying that sex has constitutive biological properties, and specifying how these properties do not support binary sex classifications, goes beyond these deflationary accounts.

With that being said, van Anders et al. (2014) and other feminist scholars (Cruz 2010; Stirnitzke 2011) caution that attempting to 'get sex right' poses a danger to feminist aims because it runs the risk of reinforcing the idea that sex is a "natural fact that can be accurately pinned down and contained in some concrete unchangeable way" (van Anders et al. 2014, 183-184). I find that this worry exhibits a false dichotomy. Attempting to clarify what sex is does not necessarily imply that one endorses the view that sex is a fixed property of the body. Rather than assuming that sex is a single bodily property that is a "natural fact," one can view sex as a *collection* of properties that are subject to change for a variety of reasons related to non-epigenetic factors, epigenetics and human attitudes. Given the broad scope of appeals to innate sex differences in formulating, e.g., legal decisions and education policy in some legal and education systems and research questions (van Anders et al. 2014;

Eliot 2011; Fine 2010; Schiebinger 2014), a socially responsible[98] way of acknowledging sex-based properties, and the limits of their connotation, is needed both within scientific practice and in other forms of social/institutional practice.

5. Conclusion

In short, I've offered a concept of sex that deflates the dominant sex classifications that appear in case law and in other institutional classification schemes. Because it is a deflationary concept, nonbaptismal sex is aimed at decoupling sex from gender especially as that conflation relates to bio/logics and the gender-coding of persons with stereotypes. At the same time, I acknowledge that identification with (usually some)[99] sex-based properties is important to the gender identities and lived experiences of some individuals, so I have incorporated self-identification as part of my new concept. Further, the nonbaptismal sex concept is aimed at restricting the use of institutional sex classifications and encouraging a holistic sex classifications in therapeutic, clinical and research settings. In their psychic life, an individual might identify with some narrow grouping of sex-based properties as meaningful to their embodied experience of their gender, but a holistic approach (one that acknowledges the full scope of someone's sex-based properties) is needed in biomedical contexts (Schiebinger 2021). What this 'holistic approach' is knowing, as in the blood type case, what someone's developmental properties are in the context of their life history.

As I discussed here and in Chapter V, sex demarcations are not simply an epistemic matter, instead they are moral and social-political. I have argued that sex demarcations, as they are currently practiced, serve as the entry point into a gendered economy where one is, in a

[98]As articulated by philosopher Janet Kourany (2010, 2013), socially responsible science incorporates sound social and epistemic values in every aspect of the research process.
[99] It is certainly possible but less likely that individuals identify strongly with their chromosome type.

variety of ways, encouraged or implored by one's social environment and institutions to 'keep the faith' in order to secure a social order of goods and services. As I aimed to highlight in *Sex on a Desert Island*, on their own, our biological properties are not laden with social meanings and they do not carry moral weight—nor should they. It is time to start talking about sex differently.

Conclusion

In the introduction to this project, I explained that I take a Finean approach to non-modal essence that I couple with conceptual engineering for moral, social and epistemic aims. Passinsky (2019) defends the coupling of real definition with Elizabeth Anderson's (1995) concerns over identifying significant truths and engaging in theory choice in light of contextual values. I developed my metaphysical and conceptual engineering accounts of sex guided by aims to provide an analysis informed by empirical approaches that are more representative of how humans interact with sex on a broader and more ordinary scale, i.e., how sex is interpreted socially and culturally, rather than the evolutionary roles of ova and sperm. My Andersonian interest in significant truths motivated me to engage in a metaphysical investigation into *what* sex is fundamentally in order to better sort through the cultural conundrum I made reference to in the introduction to this project. I have brought together a diverse range of philosophical sub-disciplinary and empirical approaches to answer this project's guiding questions.

My answers have been: sex is biological, its constitutive biological status specifies it as a biological kind and the causal powers of sex development, including emergent features, show that human sex is much more than the tick of an 'F' or an 'M.' Biological sex doesn't just shape our development, but it also can (at least partially) shape the trajectory of our lives depending on our social attitudes and practices. I have attempted to 'get sex right' despite feminist worries over doing so. I think part of having the opportunity to get anything 'right' involves having a sense of what one's scope is. My scope for this project was to offer an account of sex that has the potential to mitigate the impacts of gender-stereotyped proselytizing by deflating its broad-scale social significance. I have developed my strategic conceptual engineering approach with the target of rendering sex as a biological kind as *less* socially significant.

I am not naïve enough to suggest that 'getting sex right' through demystifying the metaphysics will diminish political polarization or disagreement over what practices we should engage in. Rather, I more humbly contend that such demystifying work can aid in certain conceptual engineering projects that may make a moral, social, and political difference in the future. I suspect that deeply held ideological commitments about sex are mostly impervious to presentations of *fact*, but rather, a softening in ideological commitment is more likely to develop in the backdrop of changes to common norms and practices. This is where I think conceptual engineering can do promising interventions as new concepts have the potential to change norms and practices, which has borne out in the replacement of concepts in scientific practice and in the rethinking of what it means to be married in the United States. What I have offered thus far, is a way to deflate sex for social aims. What I've tried to do is show here that we can still talk about sex from a biological realist perspective without assuming that biological sex is destiny (Beauvoir 1949). Although, due to reproduction and other sex differences, our social realities will likely always interact with how we are sexed, there is potential for us to change the content of our attitudes about sex to undermine the basis of our faith in gender ideology. I have offered my non-modal essentialist account of sex as mind-independent biological properties of the body to better assess other essentialist claims about sex that are biological determinist or strongly social constructionist. I have also offered my Finean account in order to better address the current cultural furore over sex and gender.

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