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Sex/Gender: Part I: Why Now?

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A Critical Moment: Sex/Gender Research at the Intersections of Culture, Brain, and Behavior

FPR-UCLA 2016 Conference Summary



Emerging theories in neuroscience – fueled by new technologies in brain imaging and recording along with torrents of new data – offer a profoundly different view of the human brain – part of a “tangled skein” of extended brain-body-behavior networks that are dynamic, plastic, adaptable, and “in constant dialog” with the environment (Rebeiz, Patel, & Hinman, 2015; Byrge, Sporns, & Smith, 2014). At the same time, shifts in how we think about sex determination, sexual differentiation, sexual orientation, and gender identities, as well as significant changes in the ecologies of sex and gender driven by globalization, are forcing us to reconsider our theoretical ideas and categories. These shifts have sparked entirely new sets of questions, debates, and tensions both between the neuro- and

social sciences and in terms of addressing sex/gender disparities. The organizers of the FPR's 6th interdisciplinary conference at UCLA (October 23–24, 2015) identified this juncture as a “critical moment” for integrating ideas from different fields on sex/gender in culture, brain, and behavior. Co-chaired by biologist [Art Arnold](#) and anthropologists [Gil Herdt](#) and [Carol Worthman](#), the conference sought to address the following questions: *Why now? What's fixed, changeable, changing? What's at stake, what makes a difference and why?*

[Anne Fausto-Sterling](#) (Brown University), who gave the keynote talk (“Gender as Process Not Trait: Dynamic Approaches to the Origins of Difference During Infancy” [link to video](#)), studies infants from a dynamic systems theoretic perspective, with a focus on the processes underlying the emergence of male/female differences in “the big three” – language, motor activity, and toy preference – by age three. She discussed some preliminary findings using data from a longitudinal study of videotaped interactions between mothers and infants aged 3–12 months. Fausto-Sterling and colleagues examined “moment by moment” interactions (from randomly selected 5-minute segments) using a mix of analytic approaches, including three-dimensional functional landscape analysis (Scarpino, Gillette, & Crews, 2014) from computational systems biology.

Fausto-Sterling theorizes that a missing piece to the gene-environment interaction model is the understanding that development is an iterative process, one that builds on prior experience. She described a kind of looping effect – a constant “spiraling, building, of behaviors and bodies and brains that work with the material at hand,” which leads to the question of “how bodies become engendered” and specific developmental pathways are formed. She likened this process to a corrugated landscape with peaks and valleys. Initially, infants are “pretty similar” at birth. “The landscape . . . begins to be differentiated both by parental behaviors and also by the actual physiology of the infants themselves.” Infants, influenced by a variety of internal and external factors, follow the sinuous, downward slope of one “attractor” valley or another. (The ridges between valleys – which are “unstable” places – are referred to as “repellers.”) Valleys in turn bifurcate and the possible pathways multiply. According to Fausto-Sterling, if we think of the different “attractor basins” each infant occupies at T2 as “variable gender expression or identity formation we can begin to develop a theoretical notion of what might be happening in early development.” Unlike the ridges of the corrugated landscape, these basins are often “quite stable” – not “fixed,” but balanced at any given moment in time between stability and change. (Valleys are of different depths and events or experiences can easily shift an infant’s pathway from one basin to another.) According to Fausto-Sterling, sensory and emotional factors relating to touch,

affection, speech, motor stimulation, and so on, “all contribute to reshaping the landscape.” By 18 months, as the valleys deepen, “children have begun to acquire gender preferences.” She warned, however, that “developmental time tables are tremendously variable and . . . will move around.” The hypothesis is that “small cumulative events have large effects.”

Even the briefest interactions between mother and infant involve complex ensembles of sensory, motor, and vocal activity. To illustrate, Fausto-Sterling showed a short clip of a mother interacting with a four-month-old infant, rich in detail – vocalizations, affectionate touch, assisted rolling and sitting, motor play, and repetition. In total, her dataset contains 600 observations of mother–infant interactions from 30 families (15 boys and 15 girls with their mothers) with a focus on 50–60 specific behaviors or sub-behaviors (infant activity, vocalization, maternal play type, maternal vocalization, etc.). A key question arises, how does a complex behavioral interaction like assisted standing, which differs between mothers of boys and the mothers of girls (the former encouraging more movement and using body praise), “get under the skin,” that is, contribute to sex/gender embodiment?

In addition to standard statistical analysis, Fausto-Sterling and colleagues use a variety of other approaches. In landscape analysis, for example, data from different behaviors are normalized and visualized on the same scale. Interestingly, much of the behavior that differed between mothers and male infants (more lifting and rocking) and mothers and female infants (more caretaking) at 3–4 months disappeared by one year, with the exception of assisted moving for boys. The other methods included 3D developmental analysis, cluster analysis, state-space grids, and longitudinal analysis.

“A tangled web of mutual, concurrent relationships”

Longitudinal analysis, in particular, is useful for examining how these subtle maternal responses to the infant become embodied. In maternal affectionate touch, for example, we see a decline in number of events and duration with age, although this behavior is still higher toward male infants. In gross motor simulations, the rate for male infants is also higher, while the decline with age is steeper. The question arises, does infant behavior at T1 shape mother response at T2? Using vector autoregression modeling combined with impulse response function, Fausto-Sterling found that male infants who walked more independently at T1 were more likely to experience greater maternal touch, greater response to infant movement, and greater maternal motor assistance at T2. On the other hand, there were “no effects of any sort for girls,” that is, mothers were not responding more to female infant movement. Such differences

reconceptualize how we think about socialization – how at least some gender stereotypes are covertly nurtured in young infants and become embodied – and suggest greater need for collaborative research that can examine these processes longitudinally, multidimensionally and multimodally. “We need to understand gender as a developmental process,” Fausto-Sterling concluded, “which can be assessed at different points in the life cycle, but cannot be measured as a fixed or archetypal trait.”

In the next talk, biologist [Arthur Arnold](#) (“Recent Discoveries and Opportunities for Improved Understanding of Sex-biasing Biological Factors”) described some of the ways in which new developments in biological research are also reconceptualizing how we think about sex/gender differences in the context of, for example, neurological disorders like Alzheimer’s, which disproportionately affects more women than men. There are two main and continuously interacting factors underlying these differences: genes and environment. Changes in one cause changes in the other and vice versa; hence the two factors are “often confounded.” Recent developments in epigenetics suggest an explanation for the confound. Epigenetic mechanisms, such as the attachment of methyl groups to pieces of DNA itself or modification of the histone proteins around which DNA is wrapped, control the expression of genes in response to environmental context or events within and even across generations. Examples of exposures or events that can lead to epigenetic changes include intrauterine levels of testosterone, stress, diet, exposure to pesticides, and – referring back to the Fausto-Sterling presentation – parental rearing. Since procedures studying epigenetic effects involve manipulating genes or altering the environment, much of the research is based on animal models.

In the second half of his talk, Arnold focused on the complexity of interactions between genes and hormones, illustrated by the case of androgen insensitivity syndrome (a female-appearing genetic male lacking functional androgen receptors due to a genetic mutation). In sex-based research, “the central dogma” contends that the *Sry* gene on the Y-chromosome initiates a cascade of events that causes the primordial gonad to differentiate into testes, which bathe the developing male fetus in testosterone. (For male infants, a smaller peak of testosterone occurs postnatally before flattening until puberty.) These early hormonal effects are considered “organizational” and result in permanent masculinization of the body; the hormonal effects occurring during puberty are considered “activational,” inducing reversible effects on already established structures. But animal research indicates that sex chromosome genes are also expressed in nongonadal tissue, including the brain, and contribute to sex differences. In songbirds, for example, administration of testosterone in females does not result in changes in a brain region allowing male birds

to sing their courtship song; similarly, removal of testosterone in males has no effect.

Understanding sex-biasing biological factors

The “four core genotypes” (FCG) mouse model has begun to tease out the effects of genetic and hormonal sex. In this model, the *Sry* gene is deleted from the Y chromosome and an *Sry* transgene is inserted on a non-sex chromosome (an autosome), producing XX and XY mice with testes and XX and XY mice with ovaries. XY⁻ denotes the absence of the testis-determining factor – these mice are gonadal females. Mice with the *Sry* transgene, denoted XY⁻ *Sry*, are gonadal males. When the latter is mated with an XX female, the end result is four types of mice: XX mice (with ovaries), XX*Sry* mice (with testes), XY⁻ mice (with ovaries) and XY⁻ *Sry* males (with testes). Experiments using FCG and other models have challenged parts of the central dogma. For example, gonadal males weigh more than gonadal females after puberty, suggesting a hormonal effect. After removing the gonads, mice look the same. But at two months post-gonadectomy, mice with a second X chromosome had higher body weight and more fat tissue than mice bred with a single X chromosome (Chen, McClosky, Itoh, Reue, & Arnold, 2013). Other advances in biological research, including studies on X inactivation and *Sry* expression in the brain, have similarly complicated our understanding of sexual differentiation. Arnold postulated “a combined and often antagonistic” effect of sex chromosome genes and hormones, with an impact on disease phenotypes and implications for the discovery of protective factors in sex-related disorders.

In a thoughtful reflection on the powerful biological turn in understanding sex differences, the next speaker – historian and philosopher of science [Sarah Richardson](#) (“Conceptualizing Sex Differences in the Human Genome”; [link to video](#)) – agreed that this was a “critical moment” in biology, not only because of methodological advances in the field, but also because of changes in the ways we think about the biological concept of “sex.” The focus has shifted downward from hormones to the molecular level. At the same time, the concept of distinct male and female sexes is no longer confined to the X and Y chromosomes, but has extended to the genome and, more recently and even less reductively, the sexome. This new understanding involves “complex causal pathways”; gene networks “pulsating with activity”; and dynamic interactions “that lead to emergent phenotypes,” including epigenetic processes, which on first view seem to challenge previous understandings of brain sexual differentiation as hardwired and female by default. But taking a step back, the goal of Richardson’s talk was to reflect on “the oddity of sex as an explanatory category in the life sciences.”

For feminist science studies scholars interested in the embodiment of sex and gender, the concept of plasticity inherent in epigenetics in particular offers a provocative framework that extends beyond academia. In this view, variability in gene expression promotes tolerance for “marginalized forms of gender expression.” Richardson mentioned the TV show *Orphan Black*, which regularly evokes epigenetic mechanisms to explain how eight characters with identical genomes are able to assume such different personalities/lives. Such visions “form an imaginary that has historically animated feminist intrigue with plasticity in biological theories of all sorts.”

Yet, Richardson argued that “we need to be realistic.” On closer examination of the assumptions underlying epigenetics in a recent paper (Nugent et al., 2015), plasticity is a necessary process to help “program” and ultimately stabilize sex differences in the brain. This aligns with three themes drawn from recent sex difference research: (1) epigenetics is involved in the “canalization and maintenance of sex”; (2) plasticity is itself sexually dimorphic; and (3) “sex is ubiquitous in the molecular architecture of the body” (i.e., “every cell has a sex,” which Richardson refers to as the “omnirelevant” concept of sex). The gendered brain may be considered by some a “heterogeneous mosaic,” to borrow Daphna Joel’s term, but a closer look at the actual ways in which epigenetic findings are interpreted in lab settings seem only to “multiply the signs and signifiers of sex at the molecular level.” According to Richardson, sex difference research could be considered just as much a reiteration and even amplification of an essentialist understanding of sex and gender as a broadening and blurring of categories.

“What is ‘sex’ and what do we want it to be?”

As governmental agencies both within the United States and Canada call for inclusion of females in all biomedical studies, Richardson urged us to think more closely about the concept of “sex”; its multiple conceptualizations; and the various “tasks” such concepts perform (Haslanger, 2000). From a biological perspective, “sex” ranges from an essentialist conception (egg and sperm) or a more functionalist one (reproduction) to the current “omnipresentalist” understanding (“every cell has a sex”). Richardson offered several reasons for the current understanding (e.g., combatting androcentrism, capturing “the full range of biological diversity,” addressing health disparities). But, she argued, an omnipresentalist understanding also “represents an extreme instance of synecdochally ascribing sex to the factors and parts of the body. It contributes to a notion of sex as a ubiquitous or pervasive sign or signifier and to a conception of bodies as divided in a thoroughgoing way into maleness and femaleness.” There are ethical, political, and social dimensions to how we operationalize sex, she continued. Given these complexities, Richardson encouraged us to reflect “on the ethics of our

ontologies of instantiating sex at a molecular level.” This *is* a critical moment, she continued. The concept of the genome is potentially essentializing our concept of sex. We should approach discourses about plasticity and programming critically and analytically, and we should consider the concept of sex as a biological process or social fact “critically, conditionally, and reflexively,” leaving open the possibility of a different ontology.

Conference co-chair and cultural anthropologist [Gilbert Herdt](#) gave the session’s final talk (“From Ritual Sex to Sexual Individuality: Sambia Sexual Culture Change over 50 Years”). Herdt’s presentation was based on long-term (1974–2010) anthropological fieldwork among the Sambia of Papua New Guinea, with a focus on the extraordinarily rapid changes in sexual behavior and expression.

Herdt’s early work focused on subjectivity, gender identity, and the Sambia’s absorption in “the polarity of maleness and femaleness in themselves and nature,” which became the subject of *Guardians of the Flute* (1981, p. 295). In Sambia society, “A man’s only certain protection against [constant warfare] is his own unbending masculinity” (p. 204), which was reinforced through ritual initiation, male-dominated arranged marriages, and secret homoerotic practices involving oral insemination to masculinize boys. Maintaining the male life force in adulthood necessitated continued vigilance, including avoidance of semen depletion and menstrual blood pollution. According to Herdt, precolonial Sambia language lacked terms for sex as a noun or verb or for sexual desire or identity, and so forth. There were also no concepts “for personal privacy or private space,” places in which to challenge society’s taboos (these concepts were developed under Christian missionization).

“Virtually all these absences and silences privileged male pleasure,” Herdt said. He noted the sharp contrast between the rigid system of male hegemony and ritual secrecy and the early world of boys, which was “almost solely populated by women,” creating “extraordinarily close emotional bonds,” before separation and male initiation at 7–10 years of age. The process of growing boys into men by fostering maternal separation/male attachment included nose bleeding as well as ingestive rites, threat of castration, and a conscious effort to “redirect erotic interest away from women to boys” in middle childhood, the aim being “mastery of aggression in war and control of male competition.”

“We sleep under the same blanket”

Following his first period of fieldwork (1974–1976), Herdt returned many times. His close observations, insights, and empathy as Sambia society refashioned itself – in contact with evangelical Christian practices,

including primary schooling for boys and girls beginning in the mid-eighties – have deeply enhanced a more person-centered ethnography over the years. But Herdt’s talk also suggests a profound cultural transformation (“we [men and women] sleep under the same blanket,” is a common epithet), as well as the loss of certain “ineffable qualities,” such as aggressive tendencies, within a single generation. Much of the change can be attributed to evangelical Christian missionaries; their influence is evident everywhere – in the construction of square houses with multiple rooms in lieu of crowded round houses and the bestowal of Christian names on children. The prevalence of “luv” marriages, and the blurring of male-female responsibilities mark a growing female sexual autonomy, male and female sexual individuality, and sexual intimacy that have entirely replaced the deep beliefs, symbolic power, and ritual secrecy around Sambia’s construction of masculinity.

The conference opened with the elegant science of Fausto-Sterling and Art Arnold, particularly the epigenetics of phenotypic variation and the structuring idea of a “sexome.” As biologists, Fausto-Sterling and Arnold share a concept of sex/gender differentiation as a biocultural, iterative process, perhaps best addressed from a systems biology perspective. On the other hand, Sarah Richardson’s critique of epigenetics urged us to question the tacit assumptions and essentialist tendencies underlying a focus on mechanistic questions. Finally, Gil Herdt’s talk demonstrated just how deeply culture interacts with embodied individuals and shapes sex/gender-related expression and behavior, and its mutability over time.

On Friday afternoon, FPR founder and president, [Robert Lemelson](#), a documentary filmmaker and psychological anthropologist on the UCLA faculty, screened [Bitter Honey](#). Shot over a seven-year period, the film explores polygamous marriages through the lens of three Balinese families (Sadra, Darma, and Tuaji). Next, filmmaker [Kathy Huang](#) presented her film ([Tales of the Waria](#)), which focuses on a group of biological men who self-identify as women—known locally as *waria* in Indonesia. Part III of our series reviews the two films in depth.

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Stay tuned for:

Part 2: What's Fixed, Changeable, Changing?

Part 3: What's at Stake?

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