SY-01 Steelman the opposite thesis

The debate concerning the nature, magnitude, and origin of psychological and behavioral sex differences remains one of the most vigorously contested domains in the behavioral sciences. The primary premise of this foundational text posits that behavioral sex differences are generally small, largely produced by systemic socialization, historically variable, and that biology-based prescriptions for how men and women should live rely on motivated, often flawed science. Proponents of this constructivist view—including Cordelia Fine, Anne Fausto-Sterling, Gina Rippon, Lise Eliot, Janet Hyde, Rebecca Jordan-Young, and Alice Eagly—argue that the dichotomy of the "male brain" and "female brain" is a cultural fiction. They assert that societal outcomes reflect systemic inequalities and gendered socialization rather than innate, neurobiological predispositions.

However, to rigorously validate this premise, one must first construct the strongest possible case against it. This analytical process—"steelmanning" the opposite thesis—requires articulating the most robust arguments from evolutionary psychology, behavioral genetics, and multivariate psychometrics. This opposing biological and evolutionary thesis contends that sex differences are substantial, deeply entrenched in mammalian neurobiology, cross-culturally universal, and evolutionarily adaptive. From this perspective, ignoring biological dimorphism in favor of social constructivism is unscientific and paradoxically harms individuals by enforcing an unnatural behavioral homogeneity. If the constructivist premise of the book is to stand, it must be able to systematically dismantle this steelman argument.

To evaluate these competing paradigms, this report deconstructs the evidence across three distinct analytical layers: physiology (the measurable biological substrate), behavior (the statistical distributions of traits), and culture (the variable social environments). By juxtaposing the strongest evidence for innate differences against the rigorous critiques mounted by feminist science, this analysis delineates the boundaries of current scientific consensus.

Layer 1: Physiology (The Measurable)

The foundational argument for innate behavioral sex differences rests on the premise of physiological dimorphism. The biological steelman posits that male and female brains are structurally and functionally distinct, shaped by diverging evolutionary pressures and permanently organized in utero by prenatal hormones.

The History of Scientific Sexism and the Search for Dimorphism

The assumption that physiology dictates disparate social roles for men and women has deep historical roots. Historians of science, such as Londa Schiebinger (1989), have detailed how eighteenth-century anatomists actively sought skeletal and anatomical markers—such as the depiction of a "female skull"—to justify the political and social subordination of women during an era that ostensibly championed universal human rights[1]. Stephen Jay Gould meticulously documented the era of craniometry, where scientists erroneously measured skull volumes to prove the intellectual inferiority of women and non-white populations, demonstrating how cultural biases shape biological measurement. Angela Saini's contemporary analyses further illustrate how science has historically been weaponized to portray women as biologically

inferior or "less evolved" than men, an endeavor that often relied on motivated reasoning rather than objective measurement.

Despite this history, the advent of modern neuroimaging appeared to vindicate the essentialist position. Early magnetic resonance imaging (MRI) studies routinely reported structural differences between male and female brains, leading to the popularization of the "male brain" (systemizing) and "female brain" (empathizing) typologies. The biological steelman leverages these findings to argue that men and women are fundamentally wired for different cognitive tasks and social roles.

However, recent exhaustive, large-scale meta-syntheses have dismantled the notion of a categorically dimorphic human brain. In a comprehensive synthesis published in *Neuroscience & Biobehavioral Reviews*, Lise Eliot and colleagues (2021) analyzed three decades of human MRI studies[2]. The analysis revealed a critical confounding variable in earlier research: brain size. Because men are, on average, physically larger than women, their brains are roughly 10% larger[3]. Once data is adjusted for absolute brain volume, biological sex accounts for approximately 1% of the variance in structural volumes at both the cortical and subcortical levels[3].

Eliot's directive to "dump the dimorphism" highlights that human brains are not categorized into distinct male and female phenotypes[2]. Gina Rippon (2019) argues that the brain is a highly plastic organ, continuously reshaped by gendered experiences and expectations[7]. Furthermore, functional measures of brain activity (fMRI) fail to reveal reliable, dimorphic neural circuits that process spatial, verbal, or emotional information[5]. Rather than falling into a binary, brains are best described as a "mosaic" of features. A fully consistent "male-typical" or "female-typical" pattern is a statistical anomaly, found in only a minority of individuals[9].

Brain Organization Theory and Prenatal Hormones

If gross neuroanatomy fails to provide a dimorphic foundation, the biological steelman retreats to neurochemistry—specifically, Brain Organization Theory (BOT). The dominant narrative in BOT maintains that early exposure to different steroid hormones, particularly prenatal testosterone, permanently "masculinizes" or "feminizes" the developing fetal brain[11]. The strongest evidence cited for BOT derives from quasi-experiments involving individuals with Congenital Adrenal Hyperplasia (CAH). Genetic females (XX) with CAH are exposed to unusually high levels of prenatal androgens and frequently display male-typical play behavior, such as a preference for vehicles over dolls[14]. Proponents argue this is definitive proof of hardwired biological sex differences.

In her book *Brain Storm: The Flaws in the Science of Sex Differences* (2010), Rebecca Jordan-Young provides the most exhaustive methodological critique of BOT[11]. Jordan-Young analyzed over 300 studies underpinning brain organization theory, revealing severe and systemic methodological shortcomings[14]. She identifies a pervasive failure of the "dose-response" rule; if prenatal testosterone masculinizes behavior, there should be a direct, measurable correlation between the degree of androgen exposure and the degree of behavioral masculinization, a correlation the literature largely fails to support[14].

Furthermore, the CAH studies are heavily confounded by the lived medical reality of the

condition. Most CAH girls undergo severe medical trauma, including repeated genital examinations, surgeries, and chronic medical stress, which drastically alters their socialization and psychological development compared to healthy controls[14]. Jordan-Young concludes that the data supporting BOT resembles a "hodge-podge pile" rather than a solid empirical structure, arguing that the theory relies on shifting, culturally subjective definitions of masculinity and femininity[11]. Cordelia Fine, in *Testosterone Rex*, corroborates this, dismantling the mythology that testosterone is the singular, evolutionary master-key that drives male risk-taking and dominance.

The Activation Role of Hormones in Social Context

The traditional evolutionary framework posits testosterone as a stable, endogenous driver of male aggression and status-seeking behavior. The biological steelman suggests that because men have significantly higher levels of circulating testosterone, they are naturally suited for competitive, hierarchical environments.

Sari van Anders (2011, 2013) revolutionized this framework with the Steroid/Peptide Theory of Social Bonds, published in *Psychoneuroendocrinology*[16]. Rather than viewing hormones merely as independent biological variables that *cause* behavior, van Anders demonstrates that testosterone is highly responsive to social context—specifically, it fluctuates based on whether an individual is engaged in competition or nurturance[19].

Van Anders' research reveals that testosterone acts as a dependent variable modulated by gendered social roles[18]. For example, engaging in infant care lowers testosterone in men, while wielding authority, engaging in competition, or achieving success raises it in both men and women[9]. Therefore, physiological differences in circulating hormones observed in adults may be the *result* of living in a heavily gender-stratified society rather than the strictly innate *cause* of it. Biology and social environment do not exist in isolation; they are engaged in a continuous, bidirectional feedback loop.

Layer 2: Behaviour (The Statistical)

While physiological dimorphism at the neural level is highly contested, behavioral differences between men and women are measurable and statistically verifiable. The debate hinges on the magnitude of these differences, their cross-cultural consistency, and the statistical methods used to interpret them. The evolutionary steelman argues that these differences are large and universal, while the constructivist position argues they are small and context-dependent.

The Gender Similarities Hypothesis

The most robust counter-narrative to the idea of vast psychological sex differences was established by Janet Shibley Hyde (2005) in *American Psychologist*. Proposing the "Gender Similarities Hypothesis," Hyde aggregated 46 meta-analyses encompassing hundreds of individual studies[9]. Using Cohen's *d* to measure effect sizes (where 0.20 is considered small, 0.50 is moderate, and 0.80 is large), Hyde found that 78% of all psychological gender differences were small or close to zero ($d < 0.35$)[9]. Hyde concluded that men and women are overwhelmingly more alike than they are different.

Hyde's hypothesis was rigorously tested and replicated a decade later by Ethan Zell, Zlatan Krizan, and Sabrina Teeter (2015) in *American Psychologist*. Conducting a massive

meta-synthesis of 106 meta-analyses representing over 12 million participants, Zell et al. found an average absolute difference of $d = 0.21$[23]. Differences in cognitive abilities, social personality domains, and psychological well-being were consistently small, remaining largely constant across age, culture, and generational cohorts[24].

Psychological Domain	Meta-Analytic Source	Effect Size (d)	Interpretation
Overall Average Difference	Zell et al. (2015)[24]	0.21	Small
Mathematics Performance	Lindberg et al. (2010)[27]	0.05	Close to zero
Verbal Ability	Hyde & Linn (1988)[28]	-0.11	Close to zero (favors females)
Risk-Taking	Byrnes et al. (1999)[29]	> 0.20 (avg)	Small to Moderate
Mental Rotation (Spatial)	Zell et al. (2015)[23]	0.57	Moderate
Physical Aggression	Hyde (2005)[9]	> 0.50	Moderate to Large

Note: Positive d values traditionally indicate higher male scores; negative values indicate higher female scores.

As the data demonstrates, cognitive differences are virtually non-existent. A meta-analysis of mathematics performance by Lindberg et al. (2010), covering 1,286,350 individuals, found an effect size of $d = 0.05$, indicating no meaningful gender difference[27]. Similarly, verbal ability shows a negligible female advantage ($d = -0.11$), leading researchers to conclude that the myth of the highly verbal female and the highly mathematical male is a statistical fiction[28].

However, the biological steelman points to the exceptions where differences are undeniable. Mental rotation—the ability to rotate three-dimensional objects in the mind's eye—yields a moderate effect size ($d = 0.57$ to 0.73), representing the largest consistent cognitive sex difference[10]. Furthermore, men consistently demonstrate higher levels of risk-taking across 14 of 16 domains analyzed by Byrnes, Miller, and Schafer (1999) in *Psychological Bulletin*, particularly in physical and intellectual risk-taking[29]. In economic negotiations, a meta-analysis of 10,888 participants by Mazei et al. (2015) in *Psychological Bulletin* showed that men secure significantly better economic outcomes than women[32]. Evolutionary psychologists argue these specific traits—spatial navigation, physical aggression, and risk tolerance—were heavily

selected for in ancestral males competing for mates and territory.

The Multivariate Challenge: The Distance Between Mars and Venus

The most formidable statistical challenge to Hyde's Gender Similarities Hypothesis—and the apex of the biological steelman—was presented by Marco Del Giudice, Tom Booth, and Paul Irwing (2012) in *PLOS ONE*[34]. Del Giudice and colleagues argued that utilizing Cohen's *d* to analyze isolated, univariate psychological traits fundamentally underestimates the true magnitude of human sex differences. Because human personality and behavior are complex, interacting matrices of traits, examining them one by one obscures how small differences aggregate to create vastly different overall profiles.

Using a representative sample of 10,261 adults assessed via the 16PF Questionnaire, the researchers utilized a multivariate effect size metric known as the Mahalanobis distance (*D*). While Cohen's *d* averages the difference on a single trait, Mahalanobis *D* calculates the distance between the multivariate centers of the entire male and female distributions. Del Giudice et al. found a global effect size of $D = 2.71$[34].

By psychological standards, an effect size of 2.71 is massive, corresponding to an overlap of only 10% between the male and female multidimensional distributions[34]. This finding suggests that while men and women may look statistically similar on a single, isolated axis (e.g., general anxiety or assertiveness), their comprehensive personality profiles are distinctly and undeniably divergent. Del Giudice argues that applying univariate statistics to multivariate biological realities is deeply flawed, thereby steelmanning the notion that male and female psychologies belong to fundamentally different distributions.

Stereotype Threat, Context, and Methodological Artifacts

Constructivist scientists counter the biological steelman by demonstrating that even the most robust behavioral differences are heavily manipulated by situational contexts and cultural framing. Cordelia Fine's *Delusions of Gender* rigorously documents how the social environment creates self-fulfilling prophecies regarding cognitive ability.

In 1999, Spencer, Steele, and Quinn published a seminal paper in the *Journal of Experimental Social Psychology* demonstrating the phenomenon of "stereotype threat"[37]. They found that when highly qualified women were informed that a difficult mathematics test was known to produce gender differences, their performance plummeted[38]. The cognitive load of worrying about confirming a negative stereotype depleted their working memory. However, when women were told the exact same test was gender-neutral and produced no differences, their performance equaled that of men[38].

Similarly, the male advantage in economic negotiations is not a fixed trait. Mazei et al. (2015) found that the gender gap in negotiation outcomes disappears or reverses when women advocate on behalf of others (which aligns with communal gender expectations), when the bargaining range is explicitly transparent, or when negotiators gain experience[32]. This indicates that differences in risk and assertiveness are not fixed neurobiological imperatives, but highly sensitive, context-dependent responses to social injunctions and role congruity.

However, a rigorous steelman requires acknowledging that stereotype threat has faced a severe replication crisis. Stoet and Geary (2012) reviewed the literature on stereotype threat in

mathematics and found that only 55% of experimental designs successfully replicated the original Spencer et al. findings[41]. Furthermore, half of those successful replications were confounded by statistical adjustments of pre-existing math scores[41]. Of the unconfounded experiments, only 30% successfully replicated the stereotype threat effect[41]. This replication failure suggests that constructivist, purely environmental explanations for cognitive performance gaps may be overstated, and that stereotype threat alone cannot bear the explanatory weight of the entire gender gap in STEM performance.

Layer 3: Culture (The Variable)

If physiology is non-dimorphic, and behavioral differences are subject to intense statistical and methodological debate, the origin of observable differences must be addressed through a cultural, historical, and evolutionary lens. The biological steelman argues that evolutionary psychology (e.g., David Buss's research showing universal mating preferences across 37 cultures) proves biology drives culture[42]. The constructivist premise argues that culture drives biology.

Social Role Theory and Biosocial Construction

Alice Eagly and Wendy Wood (1999, 2012, 2013) formalized "Social Role Theory" (later expanded to the biosocial construction model), which provides the most comprehensive, empirically validated explanation for how culture produces and sustains sex differences[43]. Eagly and Wood argue against the evolutionary psychology premise that ancient environmental pressures directly wired the brain for specific, immutable psychological traits (such as female nurturance or male competitiveness)[42].

Instead, they argue that evolution endowed humans with distinct physical differences—specifically, male size and physical strength, and female gestation and lactation[42]. These physical realities dictated a highly efficient division of labor in ancestral hunter-gatherer environments[47]. Because men engaged in hunting and warfare, and women in childcare and gathering, societies developed normative cultural expectations—gender roles—to ensure individuals developed the psychological traits necessary to fulfill their assigned labor[45]. Consequently, boys are heavily socialized to be agentic (competitive, assertive, risk-taking) and girls to be communal (nurturing, accommodating, empathetic)[46].

In a recent synthesis, Eagly and Wood (2023) demonstrated that 71% of sex differences found in psychological meta-analyses perfectly mirror the psychological effects of experimental power differences[46]. This suggests that behavioral sex differences are largely just expressions of power asymmetry. Because men have historically held more structural power, they exhibit the psychology of the powerful; because women have been subordinate, they exhibit the psychology of the subordinate[46].

Furthermore, Anne Fausto-Sterling (2012) utilizes dynamic systems theory in *Sex/Gender: Biology in a Social World* to explain how culture physically becomes biology[52]. She notes that from birth to 15 months, caregivers form intersubjective dyadic units with infants, unconsciously embedding gender through repetitive sensorimotor interactions[52]. Through differing speech patterns, handling techniques, and play styles, the cultural environment literally

wires the developing infant neural network[52]. Thus, the "nature vs. nurture" dichotomy is fundamentally false; culture and biology are co-constructed.

The Gender-Equality Paradox

The final, and arguably most potent, argument of the biological steelman is the "Gender-Equality Paradox." If Social Role Theory is entirely correct, one would logically hypothesize that as societies become more egalitarian, wealthy, and free of patriarchal constraints, sex differences should diminish. The empirical data often suggests the exact opposite.

David P. Schmitt, Anu Realo, Martin Voracek, and Jüri Allik (2008), publishing in the *Journal of Personality and Social Psychology*, analyzed the Big Five personality traits of 17,637 individuals across 55 cultures[55]. They found a highly counterintuitive result: sex differences in personality are significantly *larger* in prosperous, egalitarian, Western democracies (e.g., Scandinavia, the United States) than in patriarchal, developing nations[56]. Similarly, Stoet and Geary (2018), in *Psychological Science*, found that the underrepresentation of women in STEM fields is maximized in the most gender-egalitarian nations and minimized in less egalitarian countries (e.g., Algeria)[59].

Evolutionary psychologists interpret this paradox as devastating to the constructivist thesis. They argue that when economic and oppressive cultural constraints are lifted, men and women are finally free to express their innate, biologically evolved differences, causing the sexes to naturally and voluntarily diverge in their interests and personalities[55].

However, the feminist scientific paradigm offers a robust, empirically validated rebuttal. Breda, Jouini, Napp, and Thebault (2020), publishing in the *Proceedings of the National Academy of Sciences (PNAS)*, analyzed data from 300,000 15-year-old students across 64 countries[61]. They constructed a country-level measure of the essentialist stereotype that "math is not for girls." Breda et al. discovered that these stereotypes are paradoxically *stronger* in more egalitarian, developed nations[61]. When statistical models control for the strength of these stereotypes, the link between economic development and the STEM gender gap entirely vanishes[63].

Furthermore, Richardson et al. (2020) in *Psychological Science* demonstrated severe methodological flaws in Stoet and Geary's original paper, noting that the authors relied on an unvalidated, proprietary metric of "propensity" to graduate STEM rather than raw graduation data, leading to a formal correction of the original paper[59]. Breda's findings suggest a cultural rather than biological explanation for the paradox: economic development and legal equality do not erase gender norms; rather, they reshape them into more horizontal, insidious forms of social differentiation[64].

Distinguishing Averages from Individuals

The most pervasive scientific error in the application of biological determinism is the conflation of group averages with individual predictability. While statistical averages reveal mean differences between the sexes, they communicate nothing definitive about any specific individual.

If we assume an average psychological difference of $d = 0.21$ (as found by the Zell et al. meta-synthesis of 12 million people[24]), the normal distributions of men and women overlap by

approximately 85%. In practical, real-world terms, this means that if an employer randomly selects one man and one woman, there is nearly a 42% chance that the woman will score higher than the man on a purportedly "male-typical" trait. Even for traits with larger disparities, such as physical aggression or mental rotation ($d > 0.50$), the overlap remains substantial, and the variance *within* each sex vastly exceeds the variance *between* the sexes[9].

Furthermore, because the brain is a mosaic, an individual might possess a "male-typical" score in mental rotation, a "female-typical" score in verbal fluency, and a highly androgenized physiological response to competition, defying any cohesive gender categorization[9]. Applying population-level statistics to dictate individual educational, occupational, or social roles is statistically invalid and practically harmful[9].

While Del Giudice's Mahalanobis *D* of 2.71 successfully isolates multivariate profiles that separate the sexes at a macro statistical level, it relies on aggregating dozens of micro-traits[34]. In the lived reality of human interaction, individuals do not operate as composite statistical vectors; they operate dynamically within specific, fluid contexts. Therefore, relying on multivariate statistical aggregates to justify systemic gender prescriptions or limit individual autonomy is scientifically unwarranted.

Summary of Robust Findings

1. The human brain is not dimorphic; when controlling for absolute volume, biological sex accounts for only approximately 1% of structural variance across cortical and subcortical regions.
2. Individual human brains are "mosaics" of traits rather than cohesive, strictly binary male or female phenotypes.
3. Hormones such as testosterone are not exclusively innate drivers of behavior; they are highly plastic and responsive to social contexts, fluctuating based on engagement in competition versus nurturance.
4. The vast majority of individual psychological traits exhibit small differences ($d < 0.35$), with overlapping statistical distributions exceeding 80%.
5. Cognitive differences in mathematical and verbal abilities are close to zero; mental rotation remains the singular robust cognitive exception favoring males ($d = \sim 0.60$).
6. Men demonstrate higher average levels of physical aggression, risk-taking, and economic negotiation outcomes, though these disparities are heavily moderated by social context, experience, and role congruity.
7. Multivariate analyses (Mahalanobis *D*) demonstrate that when dozens of minor traits are statistically aggregated, global personality profiles between the sexes show profound divergence (overlapping by only 10%).
8. The Gender-Equality Paradox indicates that personality and occupational differences often maximize in wealthy, egalitarian nations rather than disappearing.
9. This paradox is heavily mediated by the strength of essentialist stereotypes, which paradoxically increase in wealthy democracies and fully explain the STEM segregation gap.
10. Systemic sex differences in behavior closely mirror the psychological effects of power asymmetries, suggesting that observed gender differences are largely manifestations of

historical and ongoing power disparities.

Contested or Open Questions

- To what exact degree do prenatal androgens (as studied in quasi-experiments like CAH) independently influence later behavioral choices when completely isolated from severe medical and socialization confounds?
- Does the widespread replication failure of "stereotype threat" in mathematics indicate that the constructivist explanation for the high-end STEM gap is insufficient?
- Is Mahalanobis *D* a more accurate representation of biological reality than Cohen's *d*, or is it a statistical artifact that artificially inflates the importance of aggregated, functionally minor traits?
- Why do essentialist cultural stereotypes (e.g., "math is for boys") strengthen in economically developed, legally egalitarian societies?
- How exactly does dynamic systems theory quantify the precise developmental threshold where cultural interaction permanently wires infant neurobiology?

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Implications for living together

When organizing couples, families, organizations, or societies, the empirical data demands an abandonment of rigid biological determinism without falling into the trap of ignoring observable statistical realities. Understanding that the human brain is a highly plastic mosaic,

profoundly responsive to social roles and power dynamics, necessitates structuring environments that do not presume capacity or preference based on sex. Because the overlap between men and women on almost all cognitive and psychological traits is vast, treating individuals as avatars of their group average is statistically irrational and stifles human capital. Organizations must recognize that disparities in outcomes—such as the male advantage in economic negotiations—are highly sensitive to context. By increasing transparency, minimizing ambiguity, and neutralizing stereotype threat, institutions can actively engineer environments that mitigate these disparities and ensure equitable evaluation. At the societal and familial level, the awareness that hormones like testosterone respond to caregiving and nurturance implies that equitable divisions of domestic labor are not biologically unnatural; rather, human physiology easily and dynamically adapts to egalitarian roles.

Crucially, avoiding the naturalistic fallacy is paramount: even if a trait were proven to have an evolutionary, innate origin, "natural" does not mean "good," "inevitable," or "optimal" for modern living. Societies and partnerships thrive best when they accommodate the extreme variance *within* the sexes, allowing individuals to navigate their roles based on specific competencies and contextual demands rather than archaic, binary prescriptions. By fostering environments that treat individuals as complex mosaics rather than categorical absolutes, families and organizations can maximize both well-being and systemic efficacy.

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