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Helen Longino and Ruth Doell

Introduction

Our intention in this essay is to bring to light the variety in the ways masculine bias can express itself in the content and processes of scientific research. The discussion focuses on the two areas of evolutionary studies and endocrinological research into behavioral sex differences. Although both have attempted to construe the relation between sex and gender, the forms of these disciplines differ from one another in significant respects. Examining them together should lead to a broader, more subtle understanding of how allegedly extrascientific considerations shape scientific inquiry.

While feminists have succeeded in alerting us to the existence of sexually prejudicial aspects of contemporary research that have implications for our understanding of sex differences, their critiques are dulled by a lack of adequate methodological analysis.[1] In her review of several collections of essays on sociobiology and hereditarianism, Donna Haraway remarks on the inconsistency of adopting a Kuhnian analysis of observation as theory- or paradigm-determined on the one hand, and asserting the incontrovertible existence of any fact on the other.[2] In the

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1. See, e.g., Ruth Hubbard, Mary Henifin, and Barbara Fried, eds. *Women Look at Biology Looking at Women* (Cambridge, Mass.: Schenkman Publishing Co., 1979); Ethel Tobach and Betty Rosoff, eds., *Genes and Gender I* (New York: Gordian Press, 1977); Ruth Hubbard and Marian Lowe, eds., *Genes and Gender II* (New York: Gordian Press, 1979); M. Kay Martin and Barbara Voorhies, *The Female of the Species* (New York: Columbia University Press, 1975); Evelyn Reed, *Sexism and Science* (New York: Pathfinder Press, 1978); and the special issue entitled "Women, Science, and Society" of *Signs: Journal of Women in Culture and Society,* vol. 4, no. 1 (Autumn 1978).

2. Donna Haraway, "In the Beginning Was the Word: The Genesis of Biological Theory," *Signs* 6, no. 3 (Spring 1981): 469–82, esp. 478.

[*Signs: Journal of Women in Culture and Society* 1983, vol. 9, no. 2]

introductory and concluding sections of the feminist anthologies to which she refers,[3] we find the authors explaining sexist science both as bad science (it asks "scientifically meaningless" questions and confuses correlation with causation) and as science as usual ("a product of the human imagination created from theory-laden facts," whose "every theory is a self-fulfilling prophecy."[4] Now, if sexist science is bad science and reaches the conclusions it does because it uses poor methodology, this implies there is a good or better methodology that will steer us away from biased conclusions. On the other hand, if sexist science is science as usual, then the best methodology in the world will not prevent us from attaining those conclusions unless we change paradigms. Only by developing a more comprehensive understanding of the operation of male bias in science, as distinct from its existence, can we move beyond these two perspectives in our search for remedies.

In this question of bias it is important to distinguish between psychological, cultural, and logical issues. The tendency of individuals to portray themselves in a favorable light by preferring certain explanations or theories over others is a psychological characteristic of those individuals, as is the tendency to resist alternative theories. What counts as a "favorable light," and the reasons those individuals link certain explanations or theories with their self-esteem, are culturally conditioned. Thus, in sixteenth-century Europe individual resistance to the heliocentric account of the relations between the earth and other heavenly bodies had much to do with the medieval idea that human uniqueness was signified by the earth's location at the center of a universe created by God. Natural philosophers complained that the new astronomy yielded absurd results in the old physics, but someone like Galileo, who (whether influenced by Pythagorean sun worship or rebellious for other reasons) did not subscribe to the dominant views of his culture, could step outside the terms of the prevailing geocentric account and simply develop a new physics. In the nineteenth century, resistance to Darwinian evolutionary theory was again a response to seeing human uniqueness threatened, this time by kinship with the non-rational and unenlightenable apes.

So, today, individual attachment to theories proclaiming the centrality of male development to the development of the human species, or to theories attributing the allegedly differential distribution of social-behavioral traits between men and women to the differential distribution of certain hormones between the sexes, has much to do with the androcentric and patriarchal beliefs of our culture. Since at least the time

3. Hubbard, Henifin, and Fried, eds.; Hubbard and Lowe, eds. Our criticism of these authors' treatment of methodological issues is not meant to deny their contribution to the perception of sexually prejudicial aspects of science.

4. Hubbard and Lowe, eds., pp. 23–24, 144, 149; Ruth Hubbard, "Have Only Men Evolved?" in Hubbard, Henifin, and Fried, eds., p. 9.

of Aristotle in the West, men have thought it important to justify their social dominance by appealing to ostensibly natural differences between males and females.[5] As feminists we can identify the influence of patriarchal culture when we look at these theories and their proponents. Understanding *that* these theories incorporate a male bias and understanding *how* this can be so are, however, two distinct enterprises.

One way to approach the second problem is by examining the logical aspects of theory construction, particularly the determination of what counts as evidence and how such evidence is related to the hypotheses it is called on to support. These methodological categories can then be used as a probe to analyze the structure of inquiry in evolutionary and endocrinological studies. While we concentrate on the biology of evolution and behavior, the analytic procedure we employ can be applied to other fields of inquiry as well.

A comprehensive understanding of bias would require, in addition, historical and sociological analysis of the institutions in which science is produced. Our analysis exposes the points of vulnerability in the logical structure of sciences to so-called external influences, such as culture, individual psychology, and institutional pressures. We shall argue that masculine bias expresses itself differently at different points in the chain of scientific reasoning (e.g., in description of data and in inference from data), and that such differences require correspondingly different responses from feminists. Feminists do not have to choose between correcting bad science or rejecting the entire scientific enterprise. The structure of scientific knowledge and the operation of bias are much more complex than either of these responses suggests.

Facts, Evidence, and Hypotheses

In our everyday world, we are surrounded by facts: singular facts (this ruby is red); general facts (all rubies are red); simple facts (the stove is hot); and complex facts (the hot stove burned my hand). Description of these facts is limited by the capacities of our sense organs and nervous systems as well as the contours of the language we use to express our perceptions. There is always much more going on around us than enters our awareness, not only because some of it occurs outside our sensory range or behind our backs, but also because in giving coherence to our experience we necessarily select certain facts and ignore others. The choice of facts to be explained by scientific means is a function of the reality constructed by this process of selection. What counts as fact—as reality—will thus vary according to culture, institutional perspective, and so on, making this process of selection one point of vulnerability to external influences.

5. See Caroline Whitbeck, "Theories of Sex Difference," in *Women and Philosophy,* ed. Carol Gould and Marx Wartofsky (New York: G. P. Putnam's Sons, 1976), pp. 54–80.

Even the facts that enter our awareness are susceptible to a variety of descriptions. Accounts may be more or less concrete ("a rough-textured, grey, heavy cube" vs. "a building stone"); more or less value-laden ("she picked up the wallet" vs. "she stole the wallet"); and focused on different aspects ("grey" vs. "hard" vs. "cubical"). A good portion of the history of epistemology and philosophy of science consists in the search for some privileged level of description. We are persuaded by arguments that such a search is futile.[6] But the possibility for multiple descriptions of a single reality means that, despite the ideals of scientific description, any given presentation of data may use terms that reflect social and cultural biases when other less value-laden or differently valued terms might do as well. This is another point of vulnerability to external factors.[7]

An even smaller proportion of the change, flow, and movement in the world that enters our awareness functions as evidence. The category "facts" and the category "evidence" are not only not coextensive; they have their being in quite different ways. The structure of the facts we actually or potentially know is a function of our perceptual and intellectual structures. Evidence is constituted of facts taken in relation to something else—beliefs, hypotheses, theories. To speak of evidence is not to speak of bare facts or data awaiting an explanation. It is, instead, to confer on those facts an epistemic relevance to a belief, hypothesis, or theory. To say that this fact (F) is evidence for this hypothesis (H) is to take F as a sign of H, or, to use logical terminology, to claim that F's being the case is a consequence of H's being true.

Statements describing facts that are taken as evidence for hypotheses can be more or less direct consequences of the statements expressing those hypotheses. For example, the singular sentence, "This swan is white," is a fairly direct consequence of the generalization, "All swans are white." In contrast, a statement describing discontinuities in the emission spectrum of hydrogen can be considered a consequence of a statement attributing different energy levels to the electron orbits of a hydrogen atom only in conjunction with a number of further assumptions that, for instance, assert a link between macroscopic phenomena like emission spectra and microscopic phenomena like atomic structure.[8] We will use the spatial term "distance" to convey the logical notion of being more or

6. John Austin, *Sense and Sensibilia* (London: Oxford University Press, 1962); Peter Achinstein, *Concepts of Science* (Baltimore: Johns Hopkins University Press, 1968), pp. 157–78.

7. For other approaches to these issues, see Paul Feyerabend, *Against Method* (London: Verso, 1975), pp. 55–119; Sandra Harding, "Masculine Experience and the Norms of Social Inquiry," in *Philosophy of Science Association 1980*, ed. Peter Asquith and Ronald Giere (East Lansing, Mich.: Philosophy of Science Association, 1981), 2:305–24.

8. Helen Longino, "Evidence and Hypothesis," *Philosophy of Science* 46, no. 1 (March 1979): 35–56.

less directly consequential. The less a description of fact is a direct consequence of the hypothesis for which it is taken to be evidence, the more distant that hypothesis is from its evidence. This distance that must be bridged between evidence and hypothesis provides yet another point of vulnerability to external influences.

Distinguishing between facts and evidence implies that which facts acquire scientific legitimacy will be a function of the theories under consideration. This in turn is determined by the explanatory needs of the scientific community, which are a function of specific social, institutional, and political goals. The concepts of evidence, and of the distance between a hypothesis and the evidence supporting it, are our primary analytical tools in the methodological examination of bias that follows. This approach facilitates comparisons within and between the areas investigated and helps make the operation of bias visible in scientific reasoning as well as in data collection and preparation.

The Role of Evidence

Both evolutionary and endocrinological studies have as part of their purpose the elucidation of human nature. Evolutionary studies are concerned with the description of human descent: what happened—the temporal sequence of changes constituting the evolution of humans from an ancestral species—and how it happened—the mechanisms of evolution. Endocrinology attempts to articulate general laws that describe how hormones influence or control anatomical development, physiology, behavior, and cognition. In the former case, researchers use the principles of the general synthetic theory of evolution to develop a historical reconstruction that can clarify what is human and what is natural about human nature. In the latter case, no history is sought; rather, universals about the natural, in the form of causal generalizations, are developed on the basis of contemporary observations, often made in experimental settings.

Both areas of inquiry take place within established research programs, which address particular kinds of questions and abide by particular conventions as to how to go about answering those questions. We will discuss a parallel series of issues for both kinds of research: what questions are asked; what kinds of data are available, relevant, and appealed to as evidence for different types of questions; what hypotheses are offered as answers to those questions; what the distance between evidence and hypothesis is in each category; and finally, how these distances are traversed. Systematically assembling and analyzing this material will make it possible to see some of the variety in the ways masculine bias functions in science.

Evolutionary Studies

The questions.—The main questions addressed in the search for human origins are standardly grouped into two categories: anatomical and social (or behavioral) evolution. Some features considered central to human development are captured by neither category, being individual behaviors (and so not anatomical) that likely facilitated, but do not of themselves involve, social behaviors. In addition to behavior, students of evolution are interested in capacities and dispositions manifested by behavior, such as intelligence and sociability. Finally, there is a set of questions concerning relations between the two types of evolution.[9]

Anatomical questions direct themselves to the nature and sequence of structural changes that differentiate humans from other primates. These include changes in the size and structure of the bones, teeth, muscles, and brain. Questions about social evolution concern interactions among these developing creatures, including such issues as the size of social groups, the emergence of social structures, the role of dominance and aggression within these structures, the development of cooperation and communication, the nature of relations between mothers and infants or between adults of the same and different sexes, the character of sexuality, and the roles of gathering and hunting in early hominid and human societies. Upright posture, bipedalism, dietary habits, and tool use are additional major subjects of inquiries into the evolution of the human features of individual behavior. Questions addressing the relations among these developments ask which anatomical developments affected which behavioral developments and vice versa.

Data.—Our general theories about evolution (which include the claim that species currently in existence evolved from earlier species rather than came into existence *de novo*) tell us which data to use as evidence for particular theories of human descent. The data base prescribed for theory regarding anatomical evolution is spare: fossils—primarily bits of ancient bone, teeth, some partial and disassembled skeletons, and a few footprints—constitute the foundation for our reconstructions. There are relatively few fossil remains of the earliest hominids—so few that the discovery of a tooth can throw accepted truths into dispute again. Twentieth-century developments in the physical and chemical sciences have, however, given us additional direction in how to read the fossils we do have by allowing us to date material and thus place the bones in evolutionary sequence.

There is more room for controversy regarding data pertaining to the evolution of human behavior. Individual, or noninteractive, physical behaviors such as mode of locomotion and diet seem to pose the fewest problems. The development of bipedalism can be read from fossil foot-

9. Clifford Jolly, ed., *Early Hominids of Africa* (London: Gerald Duckworth & Co., 1978), presents a good review of principles and methodology in human evolution.

prints and skeletal remains. Dietary habits are inferred from such phenomena as the size, shape, wear, and thickness of enamel on fossil teeth. Some claims about tool use are based on the presence of what appear to be functional objects with hominid remains. The more elusive feature of developing intellectual capacity is documented through the study of the size of fossil craniums and markings indicative of brain structure left in their interiors.

The greatest area of contention concerns data relevant to the evolution of social, interactive behavior in its relation to the development of human anatomy. Here the material appealed to includes not only the fossils used in reconstructions of individual capacities and behaviors and the estimated size and quantity of remains at hominid sites but also observations of modern human hunting and gathering societies and of modern ape and monkey societies. Since there is considerable variation among human as well as nonhuman primate groups, the relevance of the observed behavior of any one of these societies to the reconstruction of the behavior of early hominids is constantly in question. Although developments in immunology and biochemistry suggest a very close relationship between humans and chimpanzees, the description of the social behavior of any species is fraught with uncertainty, anthropomorphism, and ethnocentrism. The behavior of contemporary apes, which represent an evolved rather than an original species, is, in any case, a questionable model for the behavior of our hominid ancestors.[10]

Hypotheses.—In recent years, scientific reconstructions of human descent have centered around two focal images: man the hunter and woman the gatherer.[11] Both lines of explanation attempt an integrated story of anatomical and behavioral development intended to answer the question posed by the theory of evolution: how were developments that we deem central to an emerging human species favored by the processes of selection in the particular environments where hominid remains have been found? The two approaches differ in their assessment of the relative contributions of males and females to the evolution of the species.

10. This point is stressed by Martin and Voorhies (n. 1 above), pp. 109–10; and by R. van Gelder, "The Voice of the Missing Link," in Jolly, ed., pp. 431–49.

11. The classic source for the man-the-hunter view is Sherwood Washburn and C. S. Lancaster, "The Evolution of Hunting," in *Man the Hunter,* ed. Richard Lee and Irven DeVore (Chicago: Aldine Publishing Co., 1968), pp. 293–303. See also William Laughlin, "Hunting: An Integrating Biobehavior System and Its Evolutionary Importance," in Lee and DeVore, eds., pp. 304–20. For woman the gatherer, see Nancy Tanner and Adrienne Zilhman, "Women in Evolution. Part I. Innovation and Selection in Human Origins," *Signs* 1, no. 3 (Spring 1976): 585–608; Adrienne Zihlman, "Women in Evolution. Part II. Subsistence and Social Organization among Early Hominids," *Signs* 4, no. 1 (Autumn 1978): 4–20; Nancy Tanner, *On Becoming Human* (Cambridge: Cambridge University Press, 1981); Adrienne Zihlman, "Women as Shapers of the Human Adaptation," in *Woman the Gatherer,* ed. Frances Dahlberg (New Haven, Conn.: Yale University Press, 1981), pp. 75–120.

The androcentric man-the-hunter perspective assigns a major role to the changing behavior of males, while the gynecentric woman-the-gatherer perspective assigns that role to the changing behavior of females.

Both accounts consider the development of tool use by early hominids a critical behavioral change. As an aid to survival it favored the development of the bipedalism and upright posture necessary to wield tools effectively, and hence the anatomical changes that made new postures possible. From the androcentric perspective the development of tool use is also seen as a major factor contributing to changes in dentition that featured a reduction in the size of the (male) canines. With tool use defensive threats and displays of aggression could be accomplished by brandishing and throwing objects rather than baring or using the canines. Once smaller canines were no longer an evolutionary liability, selective pressures for reduced canine size, such as diets requiring more effective molar functioning, were free to operate. The androcentric account attributes the development of tool use itself to male hunting behavior.

By contrast, the gynecentric story explains the development of tool use as a function of female behavior, viewing it as a response to the greater nutritional stress experienced by females during pregnancy, and later in the course of feeding their young through lactation and with foods gathered from the surrounding savannah. Whereas most man-the-hunter theorists focus on stone tools, woman-the-gatherer theorists see tool use developing much earlier and with organic materials such as sticks and reeds. They portray females as innovators who contributed more than males to the development of such allegedly human characteristics as greater intelligence and flexibility. Women are said to have invented the use of tools to defend against predators while gathering and to have fashioned objects to serve in digging, carrying, and food preparation. The gynecentric view explains the change in male dentition by depicting female sexual choice as an effective selection mechanism: males with less prominent canines, more sociable and less prone to aggressive displays or behavior, were more desirable partners for females than their more dentally endowed fellows.

Distance between evidence and hypotheses.—As a model of evolutionary reasoning against which to measure other inferences, let us take Mary Leakey's discovery of the footprints preserved in compacted volcanic ash at Laetoli.[12] She uncovered three distinct sets of prints, two of which display "the raised arch, rounded heel, pronounced ball, and forward pointing big toe necessary for walking erect." The distance between the steps, and the pressure shown to have been exerted along the foot, are signs of a striding gait. Only an upright, fully bipedal creature could

12. Mary D. Leakey, "Footprints in the Ashes of Time," *National Geographic* (April 1979), pp. 446–57, esp. 452; Mary Leakey and Richard Hay, "Pliocene Footprints in the Laetolil Beds at Laetoli, Northern Tanzania," *Nature* 278 (March 1979): 317–32, esp. 317.

have left these prints; tracks of a quadruped, knuckle walker, or incompletely upright bipedal creature would differ in significant ways from the ones at Laetoli. Standard dating techniques assign these remains an age of 3.59–3.77 million years. Because bipedalism is the criterion for hominid status, this find allows anthropologists to assert with certainty that hominids developed as early as 3.59 million years ago. This inference is further enhanced, but not logically strengthened, by the nearby presence of australopithecine fossils dating to the same period. Presumably members of the hominid population whose skeletal remains were found left their footprints.

The distance between a set of footprints and claims about the origin of an anatomical and locomotive characteristic of an entire species seems large, but in this case the gap is closed by highly reliable generalizations. Observational knowledge of anatomy and physiology enables us to say that the physical features of the prints rule out the possibility that they were produced by a nonbipedal creature. Measurements of the impact produced by an upright body with a striding gait on certain types of surfaces provide direct support for giving the prints the status of evidence for bipedalism. Flecks of biotite in the stratum where the footprints were discovered made it possible to determine the prints' age by means of potassium-argon dating tests. Even when only one of the tests available for determining the age of prehistoric remains is applicable, as at Laetoli, the mutual consistency of different dating methods in other cases makes that test as reliable as the theory on which they all depend.

It is useful to consider two sorts of inferences in evolutionary studies that fall short of this close fit between data and hypotheses. The first is similar in content to Leakey's line of reasoning in the Laetoli case. Until recently many anthropologists believed that a creature called *Ramapithecus* might have been ancestral to the hominid *Australopithecus.* The basis for this hypothesis was a reconstruction of *Ramapithecus*'s jaw and dentition from isolated jaw and teeth remains, which were intermediate between clearly apelike and clearly hominid characteristics. Because the fossil evidence was incomplete with respect to *Ramapithecus*'s transitional status, it did not allow any inferences regarding the rest of *Ramapithecus*'s anatomical structure. The problem here was not a matter of finding assumptions to bridge the distance between evidence and hypothesis, but of expanding the data. As it happens, the later discovery of more complete cranial remains suggests that *Ramapithecus* is *not* the transitional species from ape to human.[13]

While the inconclusiveness of inferences regarding *Ramapithecus* can be traced to a lack of available data, inferences about the behavior of

13. David Pilbeam et al., "New Hominoid Primates from the Siwaliks of Pakistan and Their Bearing on Hominoid Evolution," *Nature* 270 (December 1977): 689–95; David Pilbeam, "New Hominoid Skull Material from the Miocene of Pakistan," *Nature* 295 (January 1982): 232–34.

subsequent hominid species raise a different set of methodological issues. Drawing conclusions about the uses and users of early tools, based on the association of distinctively shaped stones with fossil skeletal remains of *Australopithecus* and *Homo erectus,* raises several problems. First of all, there is the inference from structural features of the stones to their artifactual or (minimally) implemental character. Their roughly similar size, suitability for manual grasping, and (in the case of chipped stones) limited number of chip patterns make it highly unlikely that their concentration in these sites is fortuitous.[14] The odds of finding such uniform concentrations are low enough that the appearance of intentional selection or manufacture, in association with the presence of these stones at sites inhabited by a creature capable of making and using them, counts as evidence that they are indeed crude tools. The background assumption here seems to be the commonsense notion that, in the absence of countervailing factors, what seems to be is a good indication of what is.[15]

Generalizing about the uses and users of these tools is another matter. The stones could have been used to kill animals, scrape pelts, section corpses, dig up roots, break open seed pods, or hammer and soften tough roots and leaves to prepare them for consumption. In attempting to identify specific uses (which then serve as the basis for more elaborate accounts of hominid behavior), anthropologists frequently rely on analogies with contemporary populations of hunters and gatherers. But in contrast to the distinguishing features of anatomy shared by all humans, the behavior and social organization of these peoples is so various that, depending on the society one chooses, very different pictures of *Australopithecus* and *Homo erectus* emerge. If female gathering behavior is taken to be the crucial behavioral adaptation, the stones are evidence that women began to develop stone tools in addition to the organic tools already in use for gathering and preparing edible vegetation. If male hunting behavior is taken to be the crucial adaptation, then the stones are evidence of the male invention of tools for use in the hunting and preparation of animals. Unlike the footprints at Laetoli, the stones are not unequivocal signs of any specific tool-using behavior, nor are we in a position of waiting to discover more data as with the *Ramapithecus* remains. It is rather a matter of choosing a male-centered or female-centered framework of interpretation and assigning evidential relevance to data on the basis of that framework's assumptions.

One great contribution of the female-centered framework lies in its

14. Sherwood Washburn, "The Evolution of Man," *Scientific American* 239, no. 3 (September 1978): 194–208, esp. 201.

15. A more specific version of this principle is offered by L. G. Freeman, "A Theoretical Framework for Interpreting Archeological Materials," in Lee and DeVore, eds. (n. 11 above), pp. 262–67, esp. p. 265: "When [patterned occurrences of the elements the prehistorian studies] are derived from undisturbed contexts they indicate that patterned human behavior was responsible for their existence."

demonstration of how dependent the man-the-hunter story is on culturally embedded, sexist assumptions. At this stage the woman-the-gatherer framework offers the more comprehensive and coherent theory, but this may be due to its elaboration after and partially in response to man-the-hunter theories. Although a determined partisan of the latter could, no doubt, improve on the man-the-hunter story, we suspect that a less gender-biased theory will eventually supersede both currently contending accounts. The issue here, however, is whether there is direct evidence for either of the interpretive frameworks within which the data, in this case chipped stones, acquire status as evidential support for hypotheses regarding the dietary and social behavior of early hominids. Not only do we not now have such evidence; we cannot have it. What the study of contemporary hunting and gathering societies should teach us is that, short of stepping into a time machine, any speculation regarding the behavior and social organization of early humans remains just that.[16] This leaves framework choice subject to influences such as the speculator's preconceived and culturally determined ideas of what human beings are. The distance between evidence and hypothesis cannot be closed by anatomical and physiological knowledge, by principles from the theory of evolution, or by commonsensical assumptions. It remains an invitation to further theorizing or, as some would have it, storytelling.

Endocrinological Studies of Sex Differences

The questions.—Hormones regulate a variety of physiological functions. The role of sex hormones, the estrogens and androgens, in the development and expression of sexually differentiated traits and functioning constitutes a small but intensively researched portion of the entirety of hormonal effects. Questions that have been studied regarding the relation of sex hormones to sexual differentiation can be grouped into three general categories corresponding to the three areas in which sexual differences are believed to be manifest: effects on anatomy and physiology, effects on temperament and behavior, and effects on cognition. Within these areas are further distinctions concerning the timing and mechanism of hormonal activity which refer to whether a particular effect is due to fetal exposure that affects the organism's development, or to adolescent and adult exposure, which may have an activating or a permissive effect.[17]

16. Warnings to this effect are scattered throughout Lee and DeVore, eds. See especially the three papers by Freeman; Lewis Binford, "Methodological Considerations of the Archeological Use of Ethnographic Data"; and Sally Binford, "Ethnographic Data and Understanding the Pleistocene."

17. The analysis in the sections that follow is based on material derived from Gordon Bermant and Julian Davidson, *Biological Bases of Sexual Behavior* (New York: Harper &

The effects of androgens and estrogens on anatomical and physiological differentiation have been studied in relation to their role in the development of primary and secondary sex characteristics—reproductive organs, along with such traits as hair, voice, and body size—as well as their role in regulating postpubertal physiological functioning, including sperm production, cyclicity, and acyclicity. As research regarding the brain's relation to behavior and physiology has become more sophisticated, the role of hormones in the development and organization of the brain has also become an object of inquiry. Studies of hormonal effects on behavior have focused on sexual behavior such as copulatory positioning and the frequency and timing of sexual activity, in addition to nonsexual but seemingly gender-linked behavior and behavioral dispositions like fighting, aggression, dominance, submission, nurturance, grooming, and activity level in play. Questions about cognition address the possible influence of hormones in bringing about the well-known if not well-understood differences in verbal and spatial abilities between boys and girls. For reasons of space we shall limit our discussion to research in anatomy and physiology and in behavior.

Data.—Although there is a large amount of observational and experimental data available to serve as evidence for hypotheses regarding the relation of sex hormones to sexually differentiated characteristics, it is not highly consistent, nor is it all of the same quality. Information relevant to questions regarding anatomical and physical differentiation includes, first of all, observations of male and female body types and the correlation of these with higher and lower average levels of androgens and estrogens circulating in the body. Abnormalities in sex-linked anatomical and physiological characteristics have been correlated with deficiencies or excesses in hormonal levels, for example, the effects of castration on hair distribution and voice. In addition to data on humans, there are numerous animal studies determining the physiological effects of deliberate manipulation of hormone levels both perinatally and postnatally.

Animal experiments have also been performed to determine the effects of hormone levels on sexual behavior, such as frequency of mounting, frequency of assuming the female mating posture, and increased or decreased female receptivity. One of the most extensively studied effects of hormonal activity on nonsexual behavior involves the

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Row, 1974); Basil Eleftheriou and Richard Sprott, eds., *Hormonal Correlates of Behavior* (New York: Plenum Press, 1975); Eleanor Maccoby and Carol Jacklin, *The Psychology of Sex Differences* (Stanford, Calif.: Stanford University Press, 1974); John Money and Anke Ehrhardt, *Man and Woman, Boy and Girl* (Baltimore: Johns Hopkins University Press, 1972); Kenneth Moyer, ed., *The Physiology of Aggression* (New York: Raven Press, 1976); Susan Baker, "Biological Influences on Sex and Gender," *Signs* 6, no. 1 (Autumn 1980): 80–96; and the review articles on the biological bases of sex differences in *Science* 211 (March 20, 1981): 1265–1324.

relation of testosterone levels to frequency of fighting behavior in a variety of strictly controlled laboratory situations. In addition to the animal studies, there have been a number of attempts to correlate hormonal output with human behavioral differences. Commonly accepted stereotypes of sex-linked behaviors and their presumed correlation with different hormonal levels often provide the starting point and underlying context for more serious scientific explorations, despite the fact that the unrigorous and presumptive character of such stereotypes precludes their acceptance as genuine data. A more reliable source of information is found in controlled observations of the behavior of individuals with hormonal irregularities. Among the groups studied are young women with CAH (congenital adrenocortical hyperplasia, a condition leading to the excess production of androgens during development, also referred to as AGS [adrenogenital syndrome]), young women exposed *in utero* to progestins, and male pseudohermaphrodites (genetic males with a female appearance until puberty, at which time they become virilized).

Hypotheses.—Of the hypotheses articulated by researchers in this field, we shall restrict ourselves to only a few representative samples focused on sex differences in humans in the categories of inquiry we have distinguished.

The influence of sex hormones on the development of anatomically and physiologically sex-differentiated traits is generally acknowledged, and the mechanisms of development of the male and female reproductive systems are fairly well understood. Thus, it is widely accepted that during the third and fourth months of fetal life the bipotential fetus will develop the internal and then the external organs of the male reproductive system if exposed to androgen. Without such exposure, the fetus will develop female reproductive organs. The mechanisms of central nervous system development, while increasingly studied, are not yet as well understood. It has been hypothesized that androgen receptors play a primary role in sexual differentiation of the human brain, an assertion that rests on the assumption of sexually differentiated modes of brain organization.[18]

Hypotheses regarding the influence of sex hormones on behavior trace their impact either to their perinatal organizing effects, or direct activating or permissive effects. In the arena of sexual behavior, for example, several (largely unsuccessful) attempts have been made to attribute homosexuality to endocrine imbalances.[19] The area of nonsexual

18. Robert Goy and Bruce McEwen, *Sexual Differentiation of the Brain* (Cambridge, Mass.: MIT Press, 1980), p. 79.

19. Robert Goy and David Goldfoot, "Neuroendocrinology: Animal Models and Problems of Human Sexuality," in *New Directions in Sex Research,* ed. Eli Rubinstein and Richard Green (New York: Plenum Press, 1975), pp. 83–98. For criticism of such views, see Julian Davidson, "Biological Models of Sex: Their Scope and Limitations," in *Human Sexuality,* ed. Herant Katchadourian (Berkeley and Los Angeles: University of California Press, 1979), pp. 134–49.

behavior has also seen a proliferation of hypotheses. Steven Goldberg, along with other anthropologists, has argued that the social dominance of males is a function of hormonally determined behavior.[20] Such theorists credit aggression with the capacity to determine one's position in hierarchical social structures and then attribute aggressive behavior to the level of testosterone circulating in the organism. Even such thorough and nonpatriarchal scholars as Eleanor Maccoby and Carol Jacklin endorse the claims that males on the whole exhibit higher levels of aggressive behavior than females and that aggressive behavior is a function of perinatal and circulating testosterone levels.[21] However, Maccoby and Jacklin are much more tentative about linking aggression with such phenomena as leadership and competitiveness.[22] Regarding other possible effects, Anke Ehrhardt has argued that gender-role or sex-dimorphic behavior in humans, including "physical energy expenditure," "play rehearsal of parenting and adult behavior," and "social aggression," is influenced by perinatal exposure to sex hormones.[23]

Distance between evidence and hypotheses.—As a model of reasoning in endocrinology, we can take the studies of hormonal influence on differentiation of the genitalia in humans. The current view that testosterone secreted by the fetal testis is required for normal male sex organ development and that female differentiation is independent of fetal gonadal hormone secretion is substantiated by observations in humans and by experimental data on a variety of other mammalian species. Among the human observations, most significant are those of persons affected by various hormonal abnormalities. Genetic males who lack intracellular androgen receptors and are thus unable to utilize testosterone exhibit the female pattern of development of external genitalia. Genetic females exposed *in utero* to excess androgen, either as a result of progestin treatment of their mothers during pregnancy or due to their own adrenal abnormality, exhibit partial masculine development, including enlargement of the clitoris and incomplete fusion of the labia. These observations support the hypothesis that no particular hormonal secretion from the fetal gonad is required for female development, whereas exposure of the primordial tissues to testosterone or one of its metabolites at the appropriate time is both necessary and sufficient for masculine development of the sex organs. This inference is further corroborated by experimental data in a variety of mammalian species whose reproductive anatomy and physiology are analogous to those of humans.

20. Stephen Goldberg, *The Inevitability of Patriarchy* (New York: William Morrow & Co., 1973).

21. Maccoby and Jacklin, pp. 243–47.

22. Ibid., pp. 263–65, 274, 368–71.

23. Anke Ehrhardt and Heino Meyer-Bahlburg, "Effects of Prenatal Sex Hormones on Gender-related Behavior," *Science* 211 (March 20, 1981): 1312–18.

For instance, castration of male fetuses *in utero* invariably results in their developing a female appearance.

In contrast to the security of the hypothesis regarding sex organ development are issues regarding the biochemical pathways testosterone follows in producing its physiological effects. Because the exact mechanism of hormonal action at the cellular level is only partially understood, it is not yet certain how testosterone or one of its metabolites acts in the cell nucleus. In this respect, this issue in endocrinology is analogous to questions regarding *Ramapithecus* in evolutionary studies: lack of certainty will be allayed by more information and further analysis.

The relation between data and hypotheses becomes much more complex in attempts to link hormonal levels with behavior. The inferential steps in Ehrhardt's work on young women with CAH provide an interesting illustration of this complexity. Unlike some of the authors exploring this topic, Ehrhardt is directly engaged in aspects of the research that forms the basis of her thinking. In addition, since she is concerned with the relation between prenatal hormone exposure and later behavior, there is no question of hormone levels being an effect of behavior rather than vice versa. From the point of view of hereditarian theories of gender, Ehrhardt's work, if sound, would indicate a mechanism that mediates between the genotype and its behavioral expression. All these factors confer on her work a pivotal significance.[24]

The data Ehrhardt brings to her line of reasoning include both observations of humans and experimentation with rats. The human observations follow girls affected by CAH, using their female siblings as controls. She documents the fact of the girls' prenatal exposure to greater than normal quantities of androgens and evaluates observations of their behavior as children and adolescents. It is important to remember that these girls were born with genitalia that were surgically altered in later life and that they require lifelong cortisone treatment. The majority were said to exhibit "tomboyism," operationally characterized as preference for active outdoor play, preference for male over female playmates, greater interest in a career than in housewifery, as well as less interest in small infants and less play rehearsal of motherhood roles than that exhibited by unaffected females. One problem with these behavioral observations concerns Ehrhardt's method of data collection. Because these observations were obtained from the girls themselves and from parents and teachers who knew of the girls' abnormal physiological condition, it is difficult to know how much the reports are influenced by observers' expectations.

24. For this representation of Ehrhardt's views we rely primarily on Ehrhardt and Meyer-Bahlburg. Ehrhardt's earlier publications on this subject have been critically discussed by Elizabeth Adkins, "Genes, Hormones, Sex and Gender," in *Sociobiology: Beyond Nature/Nurture?* ed. George Barlow and James Silverberg (Washington, D.C.: American Association for the Advancement of Science, 1980), pp. 385–415.

Leaving this problem aside, let us proceed with the reconstruction of Ehrhardt's line of reasoning. She advances the hypothesis that human gender-role behavior, that is, behavior considered appropriate to one gender or the other but not to both, is influenced by prenatal exposure to sex hormones. This hypothesis is a generalization of the specific explanation offered for CAH women, namely, that engaging in a degree of gender-role behavior thought inappropriate to their chromosomal and anatomical sex is a function of their prenatal exposure to excessive amounts of androgen. It is significant that Ehrhardt's treatment of the CAH women does not consider the observational data (available in some quantity) indicating the effect of early environmental factors in shaping alleged gender-role behaviors.

What justifies the attribution of the CAH girls' behavior to physiological rather than environmental factors? To begin to answer this question, Ehrhardt appeals to research on other mammalian species that seems to show the hormonal determination of certain behaviors. The premise that physiological and behavioral phenomena are continuous throughout mammalian species allows her to assign the allegedly sex-inappropriate activities of CAH women the status of evidence for the hormonal determination of behavior. When she cites recent research on rodent brains and behavior to support her interpretation of the human studies, she is assuming that the rodent and human situations are similar enough that demonstration of a causal mechanism in one species is adequate to support the inference from correlation to causation in the other. There are several recognized difficulties with this assumption. Obviously the human brain is much more complex than the rodent brain. Second, experiments with rodents all involve single factor analysis, while human situations, including that of the CAH girls, are always interactive. Finally, some of the rodent experiments are equivocal in their support of the hormonal determination of rodent behavior.

In addition to these problems in extrapolating from the results of nonhuman animal experiments to humans, alternative explanations are not ruled out by the data Ehrhardt presents. More sociologically and culturally oriented studies have depicted the kind of behavior exhibited by the CAH girls as an outcome of social and environmental factors.[25] Such studies supply a framework within which the girls' behavior can be seen as evidence for certain early environmental influences. Equally plausible is the hypothesis that the girls' behavior is a deliberate response to their situation as they perceive it. Because the alleged tomboyism of CAH girls is not unique to them but shared by many young women

25. Margaret Mead, *Sex and Temperament in Three Primitive Societies* (New York: William Morrow & Co., 1935), is still an excellent source for this point of view. See also Beatrice Whiting and Carolyn Pope Edwards, "A Cross-cultural Analysis of Sex Differences in the Behavior of Children Aged Three to Eleven," *Journal of Social Psychology* 91 (1973): 171–88.

without demonstrated hormonal irregularities, the difference between the CAH girls and the control group is as likely a function of environment or self-determination as a direct product of their hormonal states. Support for the hormonal explanation in the CAH case must include arguments ruling out such alternative explanations. To date such arguments have not been provided.[26]

The considerable distance between evidence and hypotheses regarding the hormonal determination of behavioral sex differences contrasts sharply with the close fit between the two in the case of anatomical sexual differentiation. The human reproductive system is not significantly different from that of nonhuman mammals and the mechanism of anatomical differentiation in the latter is clearly known. While the course of development in the human embryo has not been observed directly as it has been in other species, the hypothesis of hormonal determination in humans can be seen as a causal generalization from instances where hormonal and anatomical abnormalities are correlated in humans in accordance with Mill's rules of agreement and difference in causal reasoning.[27] Because human behavioral dispositions cannot be exclusively associated with prenatal hormonal levels and receptors in the same way as anatomical conditions, the argument regarding gender-dimorphic behavior fails Mill's agreement test and falls back on animal modeling to give the data relevance as evidence in order to bridge the gap between data and hypotheses. Animal modeling, we have argued, precludes any generalization from the situation of the CAH women because it fails to support the specific inference of causation in that case. This leaves the choice of a physiological or an environmental explanation for behavior (or some alternative to the nature/nurture dichotomy), like the choice of framework in evolutionary studies, subject to the preconceived ideas and values of the researcher.

Understanding Male Bias

We consider in this section the implications of our analysis for understanding the expression of male bias in the development of theory. While there are obvious interconnections between the types of research

26. Ehrhardt (see Ehrhardt and Meyer-Bahlburg) notes that the only influence acknowledged by the parents was encouragement of "feminine" rather than "masculine" behavior. Self-reporting is not, however, the most reliable source of information in a sensitive area like child rearing. In addition, effective parental influence is rarely overt or conscious.

27. The rule of agreement states that if F is present whenever E is present and absent whenever E is absent, then F is likely to be a cause of E. According to the rule of difference, if F is present when E is absent, then F is unlikely to be a cause of E. Both presuppose the temporal priority of F to E. See John Stuart Mill, *A System of Logic,* 8th ed. (London: Longmans, Green & Co., 1949), pp. 253–59.

we have discussed, there are also some significant discontinuities and differences.

We noted at the outset that the aims of evolutionary and endocrinological studies are quite distinct. Evolutionary studies attempt to reconstruct prehistory by recovering particulars and relating them in order to describe the development of a particular species, *Homo sapiens.* On this basis, generalizations concerning the interrelation of various aspects of human existence become possible, but their production is not an immediate objective. In contrast, the goal of neuroendocrinological research is to discover the hormonal substrates of certain behaviors by developing causal or quasi-causal generalizations relating the two. To the extent that evolutionary studies are believed to reveal certain behaviors or behavioral dispositions as expressions of human nature and neuroendocrinological studies to reveal hormonal determinants of those behaviors, the otherwise quite disparate aims of these fields intersect.

At a certain historical phase in both lines of inquiry, we find researchers attempting to achieve precisely this kind of synthesis. Evolutionary studies undertaken within a certain framework have been held to demonstrate that the sexual division of labor observable in some contemporary human societies has deep roots in the evolution of the species. Some contend that man-the-hunter stories of males going off together to hunt large animals while females stayed home to nurture their young prefigure contemporary Western middle-class social life in which men engage in public and women in domestic affairs.[28] If these broadly described behaviors or behavioral tendencies could be correlated with the more particularized behaviors and behavioral dispositions studied by neuroendocrinology, a picture of biologically determined human universals would emerge. Evolutionary studies would provide the universals—gender and sex roles that have remained fundamentally constant throughout the history of the species—while neuroendocrinology provided the biological determination—the dependence of these particular behaviors or behavioral dispositions on prenatal hormone distribution. We have employed a logical analysis focused on the character and role of evidence in these areas of inquiry to show that neither claim need be accepted. Their conjunction obviously can fare no better.

It is instructive to note not only the ways these inquiries intersect but also their distinguishing features, particularly in their expression of masculine bias.[29] In evolutionary studies assigning key significance to

28. Cf. Edward Wilson, *On Human Nature* (Cambridge, Mass.: Harvard University Press, 1978; New York: Bantam Press, 1979), p. 95.

29. We follow convention in distinguishing two forms of male bias. "Androcentrism" applies to the perception of social life from a male point of view with a consequent failure accurately to perceive or describe the activity of women. "Sexism" is reserved for statements, attitudes, and theories that presuppose, assert, or imply the inferiority of women,

man the hunter, androcentric bias is expressed directly in the framework within which data are interpreted: chipped stones are taken as unequivocal evidence of male hunting only in a framework that sees male behavior as central not only to the evolution of the species but to the survival of any group of its members. In current neuroendocrinological studies, because there is no comparably explicit androcentric framework for the interpretation of data, the choice of a physiological framework is not directly related to androcentric bias. Feminists, however, have identified sexist bias in the endocrinologists' search for physiological rather than environmental explanations. One reason for attributing masculine bias to this preference is the potential, noted above, for linking physiological explanations with the androcentric evolutionary account to produce a picture of a biologically determined human nature. This possibility has raised concern that some will see in a biologically determined human nature which includes behavioral sex differences sufficient justification for maintaining social and legal inequalities between the sexes. On a personal level, many fear that men (individually or en masse) will use such a view to buttress their resistance to change. Yet these political interests are served only if one assumes that allegedly masculine characteristics are preferable or superior to allegedly feminine characteristics, that the allegedly physiological basis of these attributes makes them immutable, and that such differences provide adequate grounds for female subordination.[30] The popularity of these assumptions does not mean they can withstand critical scrutiny. Nevertheless, their prevalence explains why feminists are alarmed by attempts to provide physiological explanations for behavior.

Certainly some proponents of the physiological view are influenced by sexist motivations, either their own or those of the research directors, review committees, journal editors, and referees who create the climate in which research is produced and received. But is the physiological project itself sexist? With respect to the methodological categories of analysis connected with evidence, we can look at both the description of data presented as evidence and the assumptions mediating inferences from data to hypotheses.

Physiological explanations are clearly sexist in their description of assumed gender-dimorphic behavior. Using a term like tomboyism to describe the behavior of CAH girls reflects an initial acceptance of social prescriptions for sex-appropriate behavior.[31] This body of research is

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the legitimacy of their subordination, or the legitimacy of sex-based prescriptions of social roles and behaviors.

30. A similar treatment of the legal/social concern appears in Helen Lambert, "Biology and Equality: A Perspective on Sex Differences," *Signs* 4, no. 1 (Autumn 1978): 114–17.

31. Barbara Fried, "Boys Will Be Boys Will Be Boys," in Hubbard, Henifin, and Fried, eds. (n. 1 above), p. 37.

also androcentric and ethnocentric in its assumption that behavioral differences apparent in the investigator's culture represent human universals. However, these are problems of description and presentation; choosing a less value-laden term than "tomboy" might allow for the description of genuine differences, if they exist, that distinguish the behavior of CAH girls from that of their siblings. Cross-cultural study and a more sophisticated vocabulary for the description and classification of behavior might help to avoid the barbarisms of ethnocentrism. Thus, it is at least theoretically possible that the description of data could be revised to minimize the biases of the investigators. We would then have a catalog of human behavior, dispositions, and behavioral differences that might or might not correspond to the socially salient distinctions of sex, race, and ethnicity. Perhaps we would also find physiological correlates for some of these differences. If this is indeed possible, then the masculine bias present in much behavioral description can be considered a function of inadequate analytic and descriptive tools and therefore incidental to the general project of developing a physiological account of behavior and behavioral sex differences. Ironically, then, a feminist critique has the potential to improve and refine this area of inquiry.

Sexism does not seem intrinsic to the interpretation of data as evidence for physiological causal hypotheses. In our discussion of the distance between data and hypotheses and of the assumptions required to close that distance, we did, however, note that the assumption of cross-species uniformity and the adequacy of animal modeling is highly questionable in its application to behavior. What explains its persistence, if not the role it plays in perpetuating sexism? Historical and sociological analysis is required for a full answer to this question. We would simply remind readers that animal modeling is an important aspect of physiological psychology, the branch of science that seeks a physiological explanation for as much of the subject matter of psychology (including cognition, motivation, and behavior) as possible. The scientific attention given to animal modeling can only be understood and successfully criticized if its part in the accomplishments and aspirations of established research programs is taken into account.[32]

Conclusion

The distances between data and descriptive language on the one hand, and between data described and hypotheses on the other, leave

32. In this connection see Donna Haraway, "The Biological Enterprise: Sex, Mind and Profit from Human Engineering to Sociobiology," *Radical History Review* 20 (1979): 206–37; Stephen Rose and Hilary Rose, eds., *The Radicalization of Science: Ideology of/in the Natural Sciences* (London: Macmillan, 1976).

room for several types of androcentrism and sexism to operate. The man-the-hunter genre of evolutionary studies reveals androcentrism at work directly determining the explanatory hypotheses for which data can function as evidence. Hormonal studies display androcentrism in their description of data and sexism as a possible (but not necessary) motive behind their preference for a system of interpretation that rests on unreliable assumptions about animal modeling.

What constitutes an appropriate feminist response to masculine bias in science? Clearly this depends on the way bias is expressed in a given scientific context. Feminist anthropologists have developed alternative accounts of human evolution that replace androcentric with gynecentric assumptions while remaining within the methodological constraints of their disciplines. This strategy may not provide the final word in evolutionary theorizing, but it does reveal the epistemologically arbitrary nature of those androcentric assumptions and point the way to less restrictive understandings of human possibilities. As Donna Haraway has remarked regarding their work: "The open future rests on a new past."[33] Thus, one response is to adopt assumptions that are deliberately gynecentric or unbiased with respect to gender and see what happens.

In the case of the androcentric description of data, discerning masculine bias is only a first step. Questions remain regarding the phenomena shorn of tendentious description. Does androcentric language create or simply misdescribe its object? Some feminist critics have suggested that the entire category "sex differences" is a fabrication supported by sexism and by analytic tendencies in science that emphasize distinctions over similarities.[34] More modestly, it can be argued that the concept "tomboy" identifies but mystifies a slight difference in behavior among young women. An alternative perspective might invent a name for young women who are not tomboys and seek the determinants of their peculiar behavior. Scrutinizing the language used in the description of data can lead either to its disappearance as an object of inquiry or to the reformulation of the questions we ask about it.

When the issue concerns unreliable but not explicitly androcentric or sexist assumptions that are nevertheless suspected of being sexist in motivation, it is important not only to expose their unreliability but also to search for additional determinants. Such determinants may be embedded in the research programs that grant these assumptions legitimacy, or they may be motivated by discriminatory intent other than sexism. Hereditarianism and various forms of biological determinism have been at the service of race and class supremacy as well as male domination. Because particular assumptions motivated by sexism are

33. Donna Haraway, "Animal Sociology and a Natural Economy of the Body Politic. Part II. The Past Is the Contested Zone: Human Nature and Theories of Production and Reproduction in Primate Behavior Studies," *Signs* 4, no. 1 (Autumn 1978): 37–60, esp. 59.

34. Hubbard and Lowe, eds. (n. 1 above), p. 27.

likely to be reinforced by additional types of bias in other contexts, they will not be dislodged by exposing their relation to sexism alone. Assumptions embedded in institutionalized research programs offer a different challenge. Sometimes the critic will be able to show that their use in a given context is inappropriate. Other times she may have to be willing to take on the research project of an entire discipline.

As our methodological critique has shown, the variety of ways masculine bias expresses itself in science calls for—and permits—a variety of tactical responses. It is not necessary for us to turn our backs on science as a whole or to condemn it as an enterprise. In a number of ways, the logical structure of science itself provides opportunities for the expression of the creative and self-conscious sensibility that has characterized recent feminist attempts to transform the sciences.

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