

4 The Instinctive Mind

Citing concerns over historically high seasonal traffic and the resulting potential flight delays, a Canada goose was thinking of migrating home 2 to 3 weeks early in order to avoid the crowds, avian sources confirmed Friday.

—*The Onion* (March 31, 2019)

Autonomic systems are great for regulating internal bodily functions. They can signal hunger or sexual arousal, but to satisfy these and other needs, the organism must act in the external world. It must take steps to procure food or a mate. These behaviors call on instinctive, associative, and (where available) reasoning systems. This chapter considers the instinctive system.

The presentation is divided into three parts. The first part offers an intuitive characterization of instinctive behavior, followed by a more detailed account, including discussions of mechanistic models. The second part of the chapter considers several types of human behaviors—overeating, cooperation and cheating, in-group and out-group biases, sexual arousal and mating, and gender-specific behaviors—and asks whether they can be explained as instincts, as they are in nonhuman animals, or need to be explained as social (i.e., belief-based or reasoned) constructs. This is an empirical scientific question but also a political powder keg. I will address both issues in the third part of the chapter, but my primary focus will be the science. I will take the example of stereotypical gender behaviors and use the scientific data to tease apart biological and social contributions. The value of this exercise is to show how we can determine whether a given behavior is instinctive or a social construct. Later in the volume, the same strategy will be applied to the other behaviors.

My favorite example of instincts is perhaps the behavior of the capricorn beetle reported in Fletcher (1957). A female capricorn beetle lays its eggs in

the ridges of the bark of an oak tree. A larva emerging from a hatched egg enters the trunk of the tree when it is the diameter of a piece of straw. It will live in the tree trunk for three years, growing and transforming into a fully developed capricorn beetle. As a larva, it eats its way through the wood, with the undigested wood passing through its body into the tunnel behind it. It is not in contact with any other creature during its entombment. To prepare for its exit from the tree, the larva eats its way toward the perimeter of the trunk, to the bark, often leaving a thin film of bark unbroken. It then retreats back into the tunnel and hollows out a large chamber to inhabit. Interestingly, the chamber is spacious enough to accommodate the fully formed beetle, with some room for the action of its legs. The larva then constructs a door at the opening of the chamber with a chalky white substance disgorged from its stomach. Upon completion of the door, the larva rasps material off the sides of the chamber to ensconce itself in the wood fibers. It then sheds its skin and becomes a pupa and positions itself so that it is facing the entrance to the chamber. (Without this advance positioning, there would not be enough room in the passage for the full-grown beetle to turn around to exit the chamber.) When it is ready to leave, it breaks through the chalky white substance covering the doorway, pushes aside any refuse material, and exits the tree trunk.

How do we explain this behavior? On the one hand, it seems replete with foresight of the later stages of its own development. Planning seems to be involved (e.g., making the chamber large enough for its adult size and turning itself around to face the exit while still small), but appearances can be deceiving. We are, after all, talking about a beetle larva, a creature with very limited neural resources. The exhibited behavior is also very specific and rigid. The larva cannot exhibit this “foresight” or “planning” in any other context. The behavior must be inborn or innate to the larva (i.e., encoded in its genome), as it has not been in contact with any other creature to have learned it. The behavior is more complex than a simple reflex arc but presumably still involuntary, implying a tight causal coupling between stimulus and response.

This latter point is further highlighted in a story about squirrels related by psychologist and philosopher William James. James makes some observations about squirrels in the wild burying nuts in the ground for the winter. This behavior also seems to involve foresight and planning (anticipating the dearth of food in the winter and stockpiling it in the autumn), but as James continues the story in the context of a pet squirrel, it turns out to be otherwise (James, 1890, p. 400):

Now, as regards the young squirrel [which he has tamed], which, of course, never had been present at the burial of a nut, I observed that, after having eaten a number of hickory-nuts to appease its appetite, it would take one between its teeth, then sit upright and listen in all directions. Finding all right, it would scratch upon the smooth blanket on which I was playing with it as if to make a hole, then hammer with the nut between its teeth upon the blanket, and finally perform all the motions required to fill up a hole—in *the air*; after which it would jump away, leaving the nut, of course, uncovered.

The behavior is elicited by, indeed causally connected to, certain superficial features of the environment—the presence of a nut, an appeased appetite, and turn of the seasons—and the actions are executed even when they are unnecessary and ineffective. The behavior seems to share more properties with reflex arcs and autonomic processes than with reason and foresight. As James goes on to say, “The cat runs after the mouse, runs or shows fight before the dog, avoids falling from walls and trees, shuns fire and water . . . [n]ot because he has any notion either of life or of death, or of self, or self-preservation . . . [b]ut simply because he cannot help it” (p. 34). But unlike most reflexive and autonomic behavior, this behavior is directed at the external environment.

Interestingly, the term *instincts* has largely disappeared from the psychology literature.¹ It is difficult to find an article on instincts in American Psychological Association journals after the 1960s. In my more than 20 years of teaching cognitive psychology and cognitive neuroscience, I have never encountered the term in any textbook that I have used. However, from the latter half of the nineteenth century to the mid-twentieth century, instincts were important topics in animal and human psychology. They were discussed extensively by Charles Darwin ([1859] 1995), Herbert Spencer (1882), William James (1890), Lloyd Morgan (1903), and William McDougall (1923), among others, before falling into disrepute (Kuo, 1921) with the behaviorist takeover of psychology in the United States discussed in chapter 5. Their importance in explaining nonhuman (and human) animal behavior was reaffirmed in the 1930s to 1960s by the European ethologists, led by Konrad Lorenz (1952, 1958), Nikolaas Tinbergen (1951, 1953), and Karl von Frisch (1962), who shared the 1973 Nobel Prize in Physiology for their remarkable work.

I want to resurrect the term *instincts* and use it in a nonmetaphorical, technical manner. For this purpose, nuance and details matter. In particular, I want to ensure that the reader understands what instincts are, how they differ from reflexive, autonomic, associative, and reasoning processes,

the types of mechanistic models needed to account for them, and the types of behaviors they can and cannot explain. The following discussion relies largely on the work of William McDougall and Konrad Lorenz. While there were important differences in the two accounts, having to do with the former's commitment to psychologism (i.e., appeal to purposeful behavior) and the latter's ardent commitment to mechanism, there was also considerable overlap in their characterizations of instincts (Kalikow, 1975, 1976; Richards, 1974).

What Are Instincts?

There is considerable agreement that instincts are species-specific, adaptive behavioral dispositions, encoded into the genome by evolution, that benefit the survival and reproductive success of the organism. That is, they are inherited, not learned, as the capricorn larva example illustrates. Instincts are common to all members of a species, at least those of the same sex. For example, it is the male three-spine stickleback fish (not the female) that builds the nest, and once the female has laid eggs in it, aggressively defends them from other male sticklebacks (identified by their red breast) or indeed any red-colored object. Instincts cannot be eradicated from the behavioral repertoire of the species in which they are innate elements or acquired by the individuals of other species. Accordingly, the aggressive nest-protecting behavior of the male stickleback cannot be modified or eliminated through training, nor can it be acquired by salmon or trout through learning.

Some instincts have limited developmental windows, others are seasonal, and still others persist throughout life. For example, the suckle response in mammals is limited to newborns and is extinguished when no longer necessary. Another example of a developmental window for instincts is the predator reaction in greylag goose goslings illustrated in an experiment where Lorenz rigged a rope across two trees and moved a fake predator along the rope. The goslings reacted to the shadow of the predator but not until eight weeks after hatching. Before that, they responded only to their parents' warning call. The reaction matured at a certain time, unaffected by learning through repeated occurrences (Richards, 1974). Rutting behavior in animals such as white-tailed deer is seasonal. Fight-or-flight responses, once developed, persist throughout life.

Instincts are triggered by specific (external) environmental cues and entail specific motor responses. The feeding behavior of the herring gull chick is triggered by the red dot on the parent gull's beak. A red dot painted on a yellow stick will solicit the same behavior (ten Cate, 2009; Tinbergen,

1951). There is a reasonably tight causal connection between the stimulus and the response (with some noted exceptions) and some limited scope for modulation via learning and reasoning (where available).

The phenomenon of habituation provides an apt example of learning modulating instincts. Prairie dogs sound an alarm at the presence of a predator. They will typically give an alarm call at the detection of human footsteps, but if no actual danger befalls them after repeated exposure to human footsteps, they become habituated to the sound of footsteps and do not give the alarm. However, the alarm call continues to be sounded in the presence of nonhuman footsteps, suggesting that habituation is stimulus specific and there is no generalization to other stimuli.

There are also examples of more explicit learning, where environmental feedback is needed to fine-tune the stereotypical instinctive behavior. For instance, while male zebra finches are genetically predisposed to produce a song, they must undergo a period of listening to and practicing the song of their fathers, which will then determine the particulars of their own song. More controversially, the same point can be made about human language. It has been argued that humans are born endowed with a language-acquisition device that requires exposure to human speech at a certain stage of development (the window of opportunity) to set parameters specific to local languages (Chomsky, 1972).² These examples illustrate interactions between instinctive and learned behaviors that we will return to several times.

Described in this manner, instinctive behavior is not only automatic and deterministic but also unconscious and robotlike. Wallace Craig (1917) was perhaps the first to question this robotic conception of instincts. Based on his studies of the blond ring dove, he argued that instinctive behavior was not like unfelt reflexes but involved “an element of appetite, or aversion, or both” (p. 91). By “appetite” he meant a continuous state of agitation in the absence of the stimulus. The receiving of the stimulus is “consummatory” or satisfying for the animal—that is, it relieves the agitation and returns the animal to rest. An “aversion” is a state of agitation resulting from the presence of a certain stimulus and ceases when the stimulus is withdrawn, so we have here an insertion of the notions of affect or feelings (with positive or negative valence) between the stimulus and the behavioral response. William McDougall (1923) also adopted this insight and explicitly inserted an affective link to mediate between the stimulus and the response, noting that “every instance of instinctive behavior involves a knowing of some thing or object, a feeling in regard to it, and a striving towards or away from that object.”³ Whether this applies to the larva of the capricorn beetle is a moot point, given its limited neural endowment; but once we move up the

phylogenetic tree to birds and mammals, it becomes a much more plausible conjecture that will play a pivotal role in the tethered rationality model. I return to it several times and deal with it more thoroughly in chapter 11.

Mechanistic Models of Instincts

Perhaps the earliest proposed account of instincts was the chain-reflex theory. It was advocated by Spencer (1882), Sherrington (1952), and Pavlov (1928) and extensively developed and articulated by Konrad Lorenz (1937). The basic claim was that instinct can be explained as a complex bundle or chain of reflexes connecting the environment to the animal's sensory and motor systems. Particular environmental stimuli, in particular situations and particular developmental stages, call forth particular actions, as when the snapping of my fingers in front of your eyes inevitably results in the simple reflex of an eye blink. Rather than a simple reflex, instincts need to be accounted for by *chains* of reflexes found in autonomic systems, such as those responsible for breathing. The chain-reflex idea was not a metaphor but rather was meant to be taken literally.

Lorenz viewed the organism as a mechanism prepared to display specific stereotyped behavior in response to specific environmental stimuli. His initial chain-reflex model introduced the concepts of the “releaser” and the “innate releasing mechanism.” The specific environmental stimulus is the releaser (such as a sound or color). The releasers are external to the animal and are few and specific. The innate release mechanism, like a tightly wound spring, determines the potential or readiness of the animal to respond to the releaser. For example, the swollen abdomen and the posture of the female stickleback is the releaser that unlocks the innate release mechanism of the male's mating behavior.

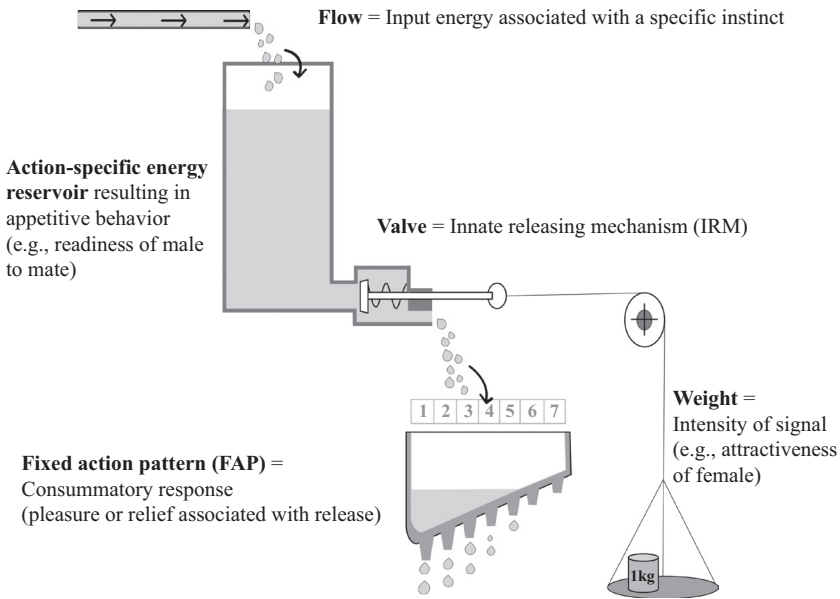
Lorenz argued that there were no overarching instincts, such as the “parental instinct” or the “reproductive instinct.” Where seemingly complex behaviors were involved, they could be broken down into more specific simple behaviors, each associated with a releaser and an innate release mechanism. In this way, the reproductive instinct in the stickleback fish might be comprised of fighting, building, mating, and caring for offspring. Mating, for example, could further be differentiated into a zigzag dance, leading a female to the nest, showing the entrance, quivering, and fertilizing the eggs. Each of these simpler behaviors would then be connected at the neural level by perception-action reflex arcs. The nerve signal generated by the presence of the stimulus would travel down fixed nerve pathways to automatically trigger the motor response.

The chain-reflex theory encountered a number of empirical difficulties. Two such problems were “intention movements” and “vacuum activities.” Intention movements are incomplete performances of a behavior or a chain of behaviors. For example, a cat may bare its teeth and raise its paw as if to attack without actually attacking (i.e., completing the behavior). This is inconsistent with the workings of reflexes. Reflexes are all-or-none; you cannot half blink your eye in response to a stimulus. Vacuum activities are behavior patterns that are initiated in the absence of the usual releaser. One example would be the attempt of the pet squirrel described by William James to bury a nut in the blanket. Another example is provided by captive raccoons. In the wild, raccoons will hold their food underwater, and make washing movements, prior to eating it. Captive, caged raccoons will engage in the same behavior with their food in the absence of water. Again, this is problematic for the chain-reflex theory because the reflex cannot be triggered without the stimulus.

Two important influences resulted in the abandonment of the literal chain-reflex model for a more metaphorical energy-based model. The first was Wallace Craig’s critical insight regarding the role of feelings in instinctive behavior that we encountered earlier. In accepting Craig’s insight, Lorenz and Tinbergen (quoted in Kalikow 1976, p. 18) noted that “subjective experience is not a chance side effect or ‘epiphenomenon’ of physiological processes! Without the ‘sensual pleasure’ which presumably represents the experiential aspect of every instinctive behavior pattern, performance of the pattern would only take place when the organism entered the elicitory stimulus situation purely by chance.” The incorporation of feelings into the theoretical account introduced the idea that the animal *wants* to engage in the behavior for the satisfaction, or positive affect, that it releases and allowed Lorenz to begin differentiating instinctive behavior from reflexes.

The second insight came from Erich von Holst’s observations that some activities thought to be caused by chain reflexes, such as the crawling movement of earthworms, are actually the result of internally produced stimuli. Holst demonstrated that if all nerves in an earthworm responsible for its creeping reflex are severed, so that no stimulus can result in a reflex action, the earthworm’s ganglia still send out the signals for the creeping motion, suggesting that the creeping movements are innate, fixed motor patterns. That is, rather than being a function of dormant reflexes triggered by a series of external stimuli, these behavior patterns are generated endogenously (Kalikow, 1975).

These insights ultimately led to the development of the metaphorical but mechanistic energy model of instinctive behavior, presented in figure 4.1.

**Figure 4.1**

The Lorenz hydraulic or energy model of instincts. Adapted from Lorenz (1950).

The central nervous system of an organism provides it with certain reservoirs of action-specific energy. Each instinct has its own reservoir. Energy is directed into the reservoir but is blocked or inhibited by a valve corresponding to the innate release mechanism, resulting in a buildup. This energy drives appetitive approach behavior in the animal (e.g., arousal and readiness of the male to mate). The valve or innate release mechanism is attached to an opening mechanism controlled by weights. The mass of the weights corresponds to the intensity of the stimulus signal in the environment (e.g., the attractiveness of a female). The opening of the valve is a function of the pressure in the energy reservoir and the mass of the weights. When the valve opens, the energy “drips” into a hierarchically organized, fixed action pattern “template,” which determines the pattern of the resulting behavior. Whether the full pattern or a partial pattern of behavior is displayed is a function of the volume of pent-up energy in the reservoir and the intensity of the stimulus (i.e., how much the valve opens). There is an affect-laden drive correlated with the volume of pent-up energy, resulting in the need to discharge, and a relief affect associated with discharging the behavior (the consummatory response). This reduces the pressure of the pent-up energy and brings the animal back to equilibrium, explaining why

an animal will actively seek environments in which a behavior or fixed action pattern can be discharged.

Despite being a metaphor, this is an important model for our purposes. It provides a tight causal connection between stimulus and response, similar to reflexes but with increased degrees of freedom. The behavior is a function of the volume of action-specific energy and the intensity of the stimulus in the environment. Each factor can have variable values. This provides flexibility but also ensures that the instinctive behavior can usually be carried out under appropriate circumstances. If an action is not initiated, the intensity of the stimulus may be insufficient and/or the energy store of the specific reservoir inadequate. An action that is initiated but not completed (i.e., an intention action) can be explained as having insufficient energy in its specific reservoir to complete the full hierarchy of responses. Vacuum behaviors can be explained as having an excessive volume of energy in the corresponding reservoir that forcefully leaks through the valve even in the absence of the stimulus. But given normal amounts of specific energy reservoirs and stimulus intensity, and all other things being equal, the stimuli are usually causally necessary and sufficient to release the stereotypical behavior.

I believe this model captures important insights about behavior that have been ignored by subsequent computational models. The work of Jaak Panksepp and other neuroscientists, which will be introduced in chapter 11, shows how Lorenz's metaphorical model can be conceptualized as a neuroscientific model by incorporating arousal and reward systems and mapping specific instincts onto specific brain stem, diencephalon, and subcortical neural circuits associated with specific neural chemistry.

Are Instincts Enough?

How far can instincts take us in explaining human behavior? That is, how much of human behavior meets the constraints of instinctive behavior and can be explained by such a mechanism?

It should be uncontroversial that some aspects of human behavior are controlled by instincts, but there is much disagreement on which ones, and how many, meet the strict criteria. Darwin ([1859] 1995) thought there was an inverse relationship between instincts and intelligence. The higher an animal was on the evolutionary scale, the fewer instincts it would have and the more intelligent behavior it would exhibit. William James (1890) thought there was no inverse ratio between instincts and intelligence. Indeed, he argued that humans have more instincts than any other species. William McDougall (1923) listed 18 human instincts in his social psychology text, including the

parental instinct; the sex instinct; the instinct of pugnacity; the gregarious instinct; the instincts through which religious conceptions affect social life; the instincts of acquisition and construction; and the instincts of laughter, imitation, play, and habit.

Some human behaviors, such as the suckle response in newborn babies, are undisputedly considered instinctive, involving mechanisms similar to those in other mammals, but as we go through even a brief selective list of human behaviors, things quickly become less clear-cut.

What about eating behavior? Many animals, particularly carnivores, overeat. Lions will eat up to one quarter of their body weight after a large kill. During a salmon run, grizzly bears eat until they can eat no more. Given that they live in a feast-or-famine environment, it is adaptive to maximize caloric intake when food is available and store the excess as fat deposits for times of scarcity. It may be many days or weeks before the lion makes another big kill and another year until the next salmon run. These behaviors are undoubtedly instinctive, but what about when humans overeat? Given that our ancestors also evolved in a feast-or-famine environment during the Pleistocene period, can my propensity to overeat also be accounted for by similar adaptive, instinctive mechanisms, or is it to be explained as a social or cultural manifestation (e.g., driven by the insidious advertising of the fast food industry)?

Some animals seem to live in socially organized cooperative groups based on reciprocity. For example, vampire bats feed on blood. If a bat returns to the communal roost without having fed, it may be in danger of starving unless another bat regurgitates blood to it. Bats that have successfully fed will regurgitate blood to those that have not (Wilkinson, 1984). It has been argued that such altruism is fitness enhancing only if the recipient bat reciprocates at some point in the future. But it is to the advantage of the recipient bat not to reciprocate (i.e., to cheat). Therefore, social animals must evolve mechanisms for detecting and punishing cheaters as an adaptive strategy to maintain the fitness of the group. Can these same mechanisms account for our railing against “welfare cheats” and my American friend’s rejection of universal healthcare, or is there more to the human story?

Many species, from bees to baboons, live in organized groups and cooperate more favorably with members of the group than with outsiders. Some of these species, such as wolves and chimpanzees, are also territorial. They mark and defend their home range against conspecifics. This behavior secures food, mates, and child-rearing resources and is therefore presumably adaptive. Humans likewise form coalitions and are territorial animals. We insist on exclusive possession for ourselves, our families, and

our communities (i.e., the “in-group”) and will fight to exclude outsiders (“out-group”). Are the same instinctive mechanisms at work in humans as in wolves and chimpanzees when people characterize immigrants as “rapists and drug dealers” and chant “Build that wall! Build that wall!” during Trump rallies, or is the story more complex?

All animals have specific behaviors associated with sexual arousal and mating. For example, during the rut, the testosterone levels in red deer bucks increase a thousandfold (Lincoln, 1971). Secondary sexual characteristics become more prominent. The bucks become less cautious than usual (making them more susceptible to hunting and motor vehicle accidents). They mark their territory and fight other bucks, sometimes to the death, to display their dominance. Their sole focus is to find, chase, and impregnate as many estrus does as possible. Different species partake in different stereotyped behaviors but to the same end. Is this also the case for human males? Can the Edwards example from chapter 1—or more generally, the numerous instances of powerful men sexually pursuing, harassing, and even assaulting women—be explained in terms of similar instinctual mechanisms or is something more in play?

In all sexually reproducing species, there are some stereotypical behaviors associated with each sex regarding courtship, territorial aggression, mating, and parental care. Human societies also assign sex-specific roles to members based on stereotypes such as “women are more emotional, caring, and nurturing” while “men are more competitive, aggressive, stronger, and less emotional.” In the case of nonhuman animals, we explain these behaviors as instinctually determined. Do the same explanations apply to humans, or is there some other explanation, such as social construction?

Darwin, McDougall, and Lorenz would certainly not hesitate in agreeing that the instinctive mechanisms that provide such convincing explanations of animal behaviors in these examples provide equally compelling explanations of human behavior. Modern evolutionary psychologists, whom we will encounter in chapter 9, would wholeheartedly concur, arguing that it is only our bruised vanity that prevents us from accepting the obvious. However, most adherents of the cognitive and social sciences intellectual framework (the standard model of rationality), which has come to dominate our thinking about human social behavior, would vociferously disagree, emphasizing socialization and reason instead.

To anticipate my own answers to these questions, I will argue that each of these five human behaviors—overeating (chapter 12), reciprocal cooperation and cheating (chapter 9), in-group/out-group bias and territoriality (chapter 13), sexual arousal and mating (chapter 11), and gender-specific

behaviors (discussed below)—have instinctive or biologically innate components. However, that does not mean that either the behaviors or the underlying mechanisms are similar across species. In fact, we will see that in some cases, human instinctive behaviors are much more elaborate than those found in other species and that in other cases they are unique to us. But critically, in all human cases, instinctual systems interact with and are modulated by reasoning systems. No other species can claim as much.

In the balance of this chapter, I would like to address two questions. The first has to do with politics, the second with science. One would think that the question of whether these behaviors are explained by innate mechanisms or as social constructs is an empirical scientific question, but such questions have become highly charged social and political powder kegs and lie at the heart of current “political correctness” debates.

The twentieth century was marked largely by a loud and bitter pushback against the view that human social behaviors are biologically or instinctively determined, or even just modulated by these systems (Ruse, 1985). This is illustrated by the reaction to the 1975 publication of *Sociobiology: The New Synthesis* by eminent Harvard entomologist Edward O. Wilson. The volume outlined the biological basis of social behaviors such as aggression, sex, parental care, territoriality, and caste roles, among others. The first 26 of its 27 chapters, dealing with nonhuman animals from ants to elephants, were universally hailed as an intellectual tour de force. However, in the last chapter, “Man: From Sociobiology to Sociology,” Wilson extended his analysis to humans and all hell broke loose. He was attacked by a broad coalition of students and academics, including friends and colleagues, in a particularly vicious, vitriolic manner. He quickly became one of the most vilified scientists of his time (Ruse, 1985). Why was this?

The second set of questions concerns the science. How do we determine whether a behavior is instinctive or a reasoned social construct? What type of evidence can be brought to bear on this question? I will use the example of gender-specific behaviors to explore and answer questions relating to both the politics and the science.

Extended Example: Are Gender-Specific Behaviors Instinctive or Social Constructs?

Society has long believed that gender identity is biologically determined by external sexual characteristics (and, more recently, chromosomes) and that sex and gender are one and the same. Implicit in this assumption is the additional assumption that there are intrinsic behavioral differences

between males and females. If societal norms are relevant in determining gender differences, it is only because boys and girls exhibit innate behavioral differences, which trigger differential treatment by parents.

Recently, a number of groups in Western societies have begun arguing that gender identity is socially constructed, independent of biological sexual characteristics (Lorber, 1995). For example, the American Psychological Association (2014) notes that “gender refers to the socially constructed roles, behaviors, activities, and attributes that a given society considers appropriate for boys and men or girls and women.” Any emerging behavioral differences between boys and girls are explained by differential treatment by parents who hold societally enforced gender stereotypes; for example, giving boys trucks and soldiers and girls dolls to play with. This differential treatment results in gender stereotypes such as women are emotional, caring, nurturing, dependent, and physically weak, while men are more competitive, aggressive, physically strong, and less emotional than women. The only correct way to assign gender is based on one’s “internal sense of being male, female, or something else” (American Psychological Association, 2014) and presumably change it as necessary. First, we will consider the politics and then the science of this fierce debate.

Politics of Gender

Many issues regarding social behaviors become politicized because they have social policy implications. Gender is one such issue. On the one side, there is outrage because of the fear that to accept a practice or norm as embedded in, or as an outgrowth of, our nature is to sanction it, even though it may be inconsistent with current social norms. If what are perceived as social flaws and inequities of our society are determined by human nature, attempts to change them will be difficult or futile. On the other side, there is fear that the failure to acknowledge any constraints on the world order “gives rise to relativism, in which everything that exists is of equal value and at the same time undifferentiated, without any real order or purpose” (Congregation for Catholic Education for Educational Institutions, 2019).

In February 2019, the Vatican released the document “Male and Female He Created Them: Towards a Path of Dialogue on the Issue of Gender and Education,” which voiced these concerns (Congregation for Catholic Education for Educational Institutions, 2019):

Gender theory (especially in its most radical forms) speaks of a gradual process of denaturalization, that is a move away from nature and towards an absolute option for the decision of the feelings of the human. In this understanding of things, the view of both sexuality identity and the family become subject to the

same “liquidity” and “fluidity” that characterize other aspects of post-modern culture, often founded on nothing more than a confused concept of freedom in the realm of feelings and wants, or momentary desires provoked by emotional impulses and the will of the individual, as opposed to anything based on the truths of existence. . . .

This ideology inspires educational programmes and legislative trends that promote ideas of personal identity and affective intimacy that make a radical break with the actual *biological difference* between male and female. Human identity is consigned to the individual’s choice, which can also change in time. These ideas are the expression of a widespread way of thinking and acting in today’s culture that confuses “genuine freedom” with the idea that each individual can *act* arbitrarily as if there were no truths, values and principles to provide guidance, and everything were possible and permissible.

While ostensibly (and ironically) appealing to biology and reason, the Catholic Church has a vested interest in upholding the world order as articulated in its religious texts. It did not take long for the document to be condemned by LGBTQ groups as harmful and encouraging hatred and bigotry (DeBernardo, 2019): “The document associates sexual and gender minorities with libertine sexuality, a gross misrepresentation of the lives of LGBT people which perpetuates and encourages hatred, bigotry, and violence against them.” These views too ostensibly appeal to science, but also have a vested interest in particular conclusions.

Who is correct? More generally, how do we differentiate a social construct from an instinct or “biological construct?” Looking *disinterestedly* at the science is always a good start. What does the science say?

Basic Science of Sex and Gender: Genes and Much More

Most species reproduce sexually by fusing together genetic materials from a male and female individual. The female is defined as the individual who contributes the physically larger gamete (ovum), and the male is the one who makes the smaller contribution (sperm). In many (but not all) species, sex is determined by chromosomes. In mammals, the XX and XY chromosomes specify female and male, respectively. All mammalian fetuses begin as females, though. This is the default mode of embryonic development. Fetuses with a Y chromosome undergo a process of masculinization as outlined in figure 4.2. It begins with the Sry (sex-determining region Y) gene initiating the formation of testes (during the sixth week in humans). Two hormones, antimüllerian and testosterone, are secreted by the testes within a certain critical window during gestation (6 to 12 weeks in humans). The antimüllerian hormone suppresses development of the female reproductive tract and genitalia. The testosterone is converted to

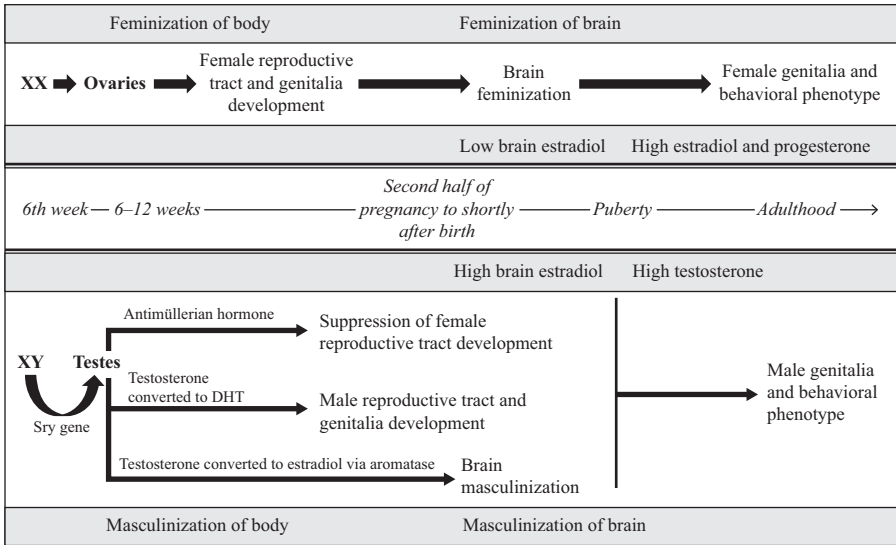


Figure 4.2
Differentiation of sex and gender in mammals.

DHT (dihydrotestosterone) by the enzyme 5-alpha-reductase and results in masculinization of the fetal body, that is, development of the male reproductive tract and genitalia (Breedlove, 1994; de Vries et al., 2014; Morris, Jordan, & Breedlove, 2004; O’Shaughnessy & Fowler, 2011; Swaab, 2007). Disruption in androgen action during the critical window will result in impaired development of the testes and penis (Matsushita et al., 2018; Place & Glickman, 2004; Welsh, Suzuki, & Yamada, 2014). There is another hormonal surge during puberty that completes sexual differentiation (de Vries et al., 2014; Lenz, Nugent, & McCarthy, 2012; MacLeod et al., 2010). The basics of this story were largely worked out in the 1940s and 1950s (Josso, 2008), but the sexual differentiation of the body is only half the story.

We accept that all nonhuman, sexually reproducing species exhibit innate gender-specific behaviors associated with courtship, territorial aggression, mating, and parental care. Insofar as all behaviors are determined by brain systems, these behavioral differences must also be underwritten by neural sexual dimorphism; that is, by structural and neurochemical differences in male and female brains. The process of masculinizing the mammalian brain involves the conversion of testosterone to estradiol by the enzyme aromatase. The critical window for this process is the second half of pregnancy in humans. These hormonal processes serve to permanently sculpt developing

neural systems by, among other things, either inhibiting or facilitating neural apoptosis (cell death) and modulating the formation and elimination of synaptic connections, in certain key subcortical brain regions such as the sexually dimorphic nucleus of the preoptic area (SDN-POA) in the anterior hypothalamus. One easily observable consequence of this process is that the SDN-POA area of the brain is several times larger in male rats than in females, and lesions to the POA eliminate copulatory behaviors in male rats. These brain differences are driven by perinatal secretion of testosterone during the critical window. Introduction of testosterone outside this window has no effect on the size of the SDN-POA in rats (Lenz et al., 2012; MacLusky, Naftolin, & Goldman-Rakic, 1986; Matsuda et al., 2011; Morris et al., 2004; Nugent et al., 2015; Sato et al., 2004; Wu & Shah, 2011; Zuloaga et al., 2008). Thus, the normal unfolding of the gestation process results in a fetus with a male brain and a male body or a female brain and a female body (figure 4.2).

In the vast majority of cases, these basic processes unfold normally.⁴ However, notice the role of the Y chromosome; it determines the release of androgens at two different time points for two different purposes: masculinizing the body and masculinizing the brain. The independence of these processes means that there are two ways in which the modulation of the timing and/or quantity of hormone release can result in transsexuality (Swaab, 2007). Similarly, even in the “default” female developmental processes, hormonal imbalances during critical periods can disrupt normal sex and gender development (Nordenström et al., 2002). Furthermore, the process can also break down at the chromosomal level, as in the case of Klinefelter syndrome (Smyth & Bremner, 1998).

The development of sex and gender has been extensively studied and experimentally manipulated in animal models. Androgen modulation prenatally, and even neonatally, can affect sex-specific behaviors such that females exhibit greater same-sex aggression and males exhibit greater female-specific behaviors, such as lordosis (downward curvature of spine) (Clemens, Gladue, & Coniglio, 1978; Clemens & Gladue, 1978; Edwards & Burge, 1971; Gladue & Clemens, 1980; Huffman & Hendricks, 1981; Palanza et al., 1999; Rines & vom Saal, 1984; Schechter, Howard, & Gandelman, 1981; Tobet & Baum, 1987; vom Saal, 1979; Ward & Renz, 1972). In the first such experiment, the female offspring of guinea pigs that were administered testosterone during pregnancy and again as adults displayed reduced lordosis behavior and increased male-like copulatory mounting behavior. Control guinea pigs that received testosterone only as adults did not display this reversal in sexual behavior (Phoenix et al., 1959). In certain

birds, song vocalizations are associated with males. There are corresponding neural differences underlying this vocal dimorphism. Female zebra finches will develop a male-like song system (along with corresponding neural substrate) after treatment with estradiol as nestlings (Pohl-Apel, 1985; Simpson & Vicario, 1991).

Most of this research has been done with nonhuman animal models. Among these animal models, there is considerable agreement on the overall processes of sexual differentiation of bodies and brains, though details continue to be revised and fine-tuned (Cahill, 2006; McCarthy, 2016). Two basic problems arise in applying the animal models to humans. (1) The manipulations and experimental techniques used to generate the results in rats, guinea pigs, and ferrets cannot, for obvious ethical reasons, be applied to humans. Therefore, we cannot directly investigate whether the same systems are at work in humans. (2) In these animal models, the notion of “male” and “female” behaviors is tightly constrained to courtship, mating, territorial aggression, and parental care. Human behavior is much more nuanced and extensive. In fact, insofar as it is a product of the rational mind, I am arguing that it is qualitatively different from nonhuman behaviors. So perhaps gender-specific behaviors in humans are built by the rational mind based on societal and cultural expectations rather than via sculpting of brain systems by hormonal processes. The way to approach this issue is, in the first instance, to restrict ourselves to the same basic behaviors that have been studied in the animal models and ask whether there are similar typical “male” and “female” behaviors in humans and, if there are, whether they are socially and culturally learned or have a biological basis.

There are data that speak to these issues. As an example, I will briefly consider the data on children’s play and toy preferences. In every culture, there are differences in the types of play and toys that interest girls and boys. This is largely uncontroversial. What is controversial is whether these differences are determined by learning—to ensure that boys and girls grow up to accept their socially and culturally mandated gender roles—or have some gender-specific biological basis (Connor & Serbin, 1977; Goldberg & Lewis, 1969; Hines et al., 2016; Taylor, Rhodes, & Gelman, 2009). Disentangling the two is not trivial, but neither is it impossible (Eliot, 2011).

One strategy is to test infants prior to extensive socialization. In eye-tracking studies of young infants from three to eight months old, girls showed a visual preference for dolls, while boys showed a visual preference for trucks, suggesting differential inborn sensitivity to low-level perceptual features associated with the different objects prior to awareness of gender categories (Alexander, 2003; Alexander, Wilcox, & Woods, 2009). Given

such a finding, one can also test nonhuman animals for similar dimorphic perceptual preferences. These sex-dimorphic preferences for object features have been detected in vervet and rhesus monkeys, using objects similar to those in the studies of children, suggesting it is an evolutionary adaptation that arose earlier than the hominid line (Alexander & Hines, 2002; Hassett, Siebert, & Wallen, 2008).

Another strategy is to see whether these preferences change as a result of different levels of androgens during early fetal development. In a longitudinal study involving 342 male and 337 female children, levels of testosterone in mothers were measured during pregnancy and were later correlated with the gender role behavior of the children as they developed. Higher levels of prenatal testosterone in the mother were positively correlated with young (3.5 years) girls being more interested in toys, games, and activities typically associated with boys. This relationship held even when social factors such as the presence of male or female siblings, parental commitment to traditional sex roles, and the presence of a male partner in the household were taken into consideration. This relationship also held in a group of young adults whose exposure to prenatal androgen levels was estimated using the “digit ratio marker” technique. Young women with more masculinized digit marker differences showed more preference for male-typical toys and activities (Alexander, 2006). There was no relationship between a mother’s prenatal testosterone levels and behavior in boys (Hines et al., 2002).

Girls with congenital adrenal hyperplasia (CAH) are exposed to excessive levels of androgens in early fetal development. This provides another opportunity to test the hypothesis of hormonal versus social environment contributions to gender determination. In one study, CAH girls three to eight years old showed a preference for boys’ toys and a reduced preference for girls’ toys compared to their unexposed female relatives of similar age and raised in similar environments (Berenbaum & Hines, 1992). Another sample of young CAH girls displayed a greater preference for playing with boys compared to their unexposed female relatives of a similar age (Hines & Kaufman, 1994). These preferences are even modulated by the *level* of fetal androgen exposure (Nordenström et al., 2002). By contrast, boys exposed to increased levels of fetal androgens do not display any such differences.

These data, as far as they go, are consistent with the animal data. To interpret these data as indicating that gender differences are socially constructed in the absence of biological, hormonal factors is to misconstrue the science. To interpret these data as indicating that chromosomal differences

constitute gender differences is also to misconstrue the science. Both sides of the political divide are (intentionally?) getting it wrong.

The Church is wrong because the science is saying that gender ambivalence is very real. Those claiming that gender is a social construct are wrong because the studies show that the sex-dimorphic preferences under consideration can be detected very early in human infants prior to any social gender category formation, are present in other species, and vary as a function of fetal androgen exposure. These data are speaking to the importance of biological factors, but they are *not* precluding the role of environmental factors. In fact, many mediating environmental factors are actually biological, including prenatal exposure to hormones, medications, environmental chemicals, and stress on the mother during pregnancy (Coolidge, Thede, & Young, 2002; Dessens et al., 1999; Zucker et al., 1996). Environmentally mediated events in the unfolding of the two separate processes triggered by the presence of the Y chromosome can result in gender ambivalence.

Perhaps what is really at issue is the extent to which postnatal social and cultural environmental factors—based on beliefs and reasons—will interact with the biological factors. We understand much less about this. The most charitable counterinterpretation of the data is that even if prenatal biological and environmental factors do not mandate specific gender identities, sexual dimorphism surely predisposes humans to be more receptive to certain socially presented gender-specific cues than to others (McCarthy, 2016).

It is also important to acknowledge the huge gap between these biological predispositions (which should be understood as statistical distributions) and societally constructed gender norms and expectations discouraging and even prohibiting women from being doctors, judges, engineers, or from voting, running for political office, and other traditionally male pursuits. These prohibitions are not mandated by biological predispositions. They are largely social constructs that typically ensure men's dominant role in society. They have been and will continue to be questioned and corrected in response to social, educational, economic, and technological factors. This is the defining characteristic of social constructs.

Such an account is consistent with the two themes of this book: (1) that human behavior is qualitatively different from the behavior of other animals, meaning we are endowed with the ability to reason; and (2) that we have been generated by the same evolutionary processes as all other animals so we are not exempt from the laws of biology. This is another way of saying that the reasoning mind is tethered to simpler associative, instinctual, and autonomic processes.

The purpose of this extended example is fourfold. First, I use it to indicate that whether a certain behavior is a social construct or has a biological basis is an empirical not political issue. Answers to the following five questions can help us distinguish between the social and biological: (1) Is the trait universally present in human societies or is it culture specific? (2) Is it available on other branches of the phylogenetic tree? (3) Does it emerge early in human infants, prior to any opportunity for extensive socialization? (4) Is it underwritten by implicit, automatic, low-level mechanisms? (5) Is it possible to trace specific subcortical neural circuitry and neurochemistry devoted to it (and find homologous behavior and circuitry in other species)? Affirmative answers to all or most of these questions are indicative of instinctively determined systems. Affirmative answers to these questions do not preclude a modulating role for reason and socialization in humans.

Second, to say that something has a biological basis is not to say that it is simply a matter of genetics. Genetics may be the starting point, but the prenatal and postnatal environments in which the neural development unfolds has an enormous impact on the resulting brain organization. The social environment will also matter, though only postnatally. It will also impact behavior by sculpting neural systems. In this sense, being a social construct or having a biological basis are not mutually exclusive categories. Both result in changes to brains, which in turn changes behavior. This issue is further considered in chapter 14.

Third, I'm not interested in dictating social policy or advocating for one position or the other. My own personal view is to live and let live. But if you are in the business of advocating for specific policies and changing human behavior to conform to those policies, it is in your interest to get the science right. You will have a better chance of modifying behavior if you have an accurate model of what is actually driving it.

Fourth, nothing I've said here will actually matter to the two sides of this debate. Just as the science of climate change failed to sway skeptical minds in chapter 1, the basic science of sex and gender identity presented here will fail to change many minds on either side of this particular battlefield. This is not rational. Why not revise false beliefs in the face of counterevidence? Why this should be the case is a fascinating question that will be addressed in chapter 13, once the machinery of tethered rationality is in place. Ironically, the answer itself will involve constraints on the system of rationality by lower-level biological constructs.

The extent and nature of biological constraints on rational choice lie at the core of the argument being developed in this volume. The politicization of these issues has not only generated fear and rage but also prevented us

from developing more realistic models of rationality. Wanting the world to be a certain way doesn't make it so. Human behavior is not on a tight biological leash like that of the larva of the capricorn beetle, but neither does our system of rational choice float unfettered above the biology. We need a commonsense model of tethered rationality.

* * *

The examination of the characteristic features of the instinctive mind illustrates both its strengths and its weaknesses in accounting for human behavior. Instincts are an inexpensive solution to guiding behavior that is essential, is needed prior to any opportunity for learning, has high cost associated with error, and does not need to change across generations. In such circumstances, instincts are the preferred solution. But their very strengths—automaticity, innateness (availability from birth), the stimulus being (usually) causally necessary and sufficient for triggering a response, and largely realizable in hardwired brain stem, diencephalon, and subcortical systems (see chapter 10)—also constitute their limitations. Instincts do not allow for learning. They do not allow for novel or flexible responses to stimuli. They do not allow for reason. We are not born knowing that fruit bats spend afternoons hanging from tree branches or that the Earth is undergoing a general warming trend. We learn these things through observation and reason. Given the limitations of the instinctive mind, we must look for additional mechanisms to explain learning and rationality.⁵

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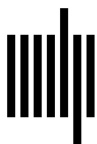
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