Faculty of Arts and Sciences
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FAS reports

Postgraduate XIII: The Lindback Scholar

The Christian R. and Mary E. Lindback Awards for Distinguished Teaching were established in 1961 to honor teacher-scholars who provide "teaching that is intellectually demanding, unusually coherent and permanent in its effect." Each year, eight faculty are honored—four in the health areas and four in the non-health areas.

This past fall the Society of the College, the alumnae and alumni of the arts and sciences, decided to feature at its 13th annual postgraduate program for alumni several of these award winners. Seven faculty were invited to speak on a topic of their choice which would illuminate some aspect of their research.

The seven were:

Dr. Robert F. Giegengack, Associate Professor and Chairman of Geology, who spoke on *Natural vs. Man-made Disasters: the Potential for Prediction or Avoidance,* a comparison of Three-Mile Island and Mt. St. Helens;

Dr. Humphrey Tonkin, Professor of English and Coordinator of International Programs, who discussed *Literature: Coping with Today and Tomorrow;*

Dr. Robert F. Lucid, Chairman and Professor of English, who spoke on *The American Writer as Celebrity;*

Dr. Christian J. Lambertsen, Professor of Pharmacology and Experimental Therapeutics and Director of the Institute for Environmental Medicine who described *Aspects of Undersea and Environmental Medicine at the University of Pennsylvania;*

Dr. Norman Adler, Professor of Psychology and Chairman of the undergraduate major, Biological Basis of Behavior, who lectured on *Interactions Between Sexual Behavior and Physiology in Animals and Man;*

Dr. Alan Mann, Associate Professor of Anthropology and Associate Curator of Physical Anthropology, who discussed *Humankind Yesterday, Humankind Today,* a look at some aspects of human evolution; and

Dr. Michael Zuckerman, Associate Professor of History, who spoke on *Dreams that Men Dare to Dream: Ideas and Realities in Western Modernization.*

Following are excerpts from the talks given by Drs. Adler, Mann and Zuckerman.

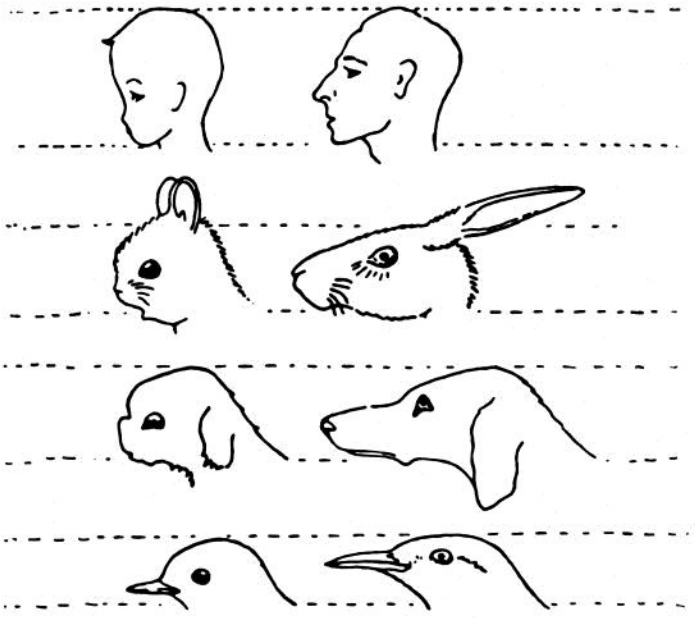
Sexual Behavior and Physiology

Norman Adler

I would like to talk about the nature of explanation in one branch of behavioral science—that of behavioral biology—focusing on the relationship between sexual behavior and physiology, particularly its biopsychological aspects.

There are really *two* distinct approaches to explanation in behavioral biology, both dating from the Aristotelian doctrine of causality. Aristotle listed four "types" of causal explanation: the material, formal, efficient, and final. Of these, one has become the common-sense notion of cause in modern science. This is the efficient cause, which corresponds closely to our notion of mechanism. Why do members of a given species engage in a particular pattern of sexual behavior? The (biologically) mechanistic answer would be "because the hormones activate a certain set of nerve cells in the brains of the animals, and these nerve cells cause the firing of a particular set of muscles." Thus, the copulatory lock of dogs is ascribed to the reaction of hormone-sensitive muscles in the male and female sexual apparatus.

There is, however, another kind of question that is also interesting and actively pursued. This is the *functional* explanation which explains behavior not in terms of its causes but in terms of its consequences. What is the function of the copulatory lock of dogs? What is it good for? Unfortunately, there is no good functional explanation for this phenomenon—but there are good functional explanations for other aspects of animal sexuality and I shall discuss some of these today.



Such external stimuli as a short face in relation to a large forehead, the ratio of eye size to head size, and protruding cheeks, as depicted in the figures on the left, release parental reactions in humans while the adult figures on the right do not. (Drawings from The Study of Instinct *by N. Tinbergen. Oxford University Press, 1951.)*

One of the most intriguing functional problems in sexual behavior concerns the peacock's tail. Why does the male possess this aesthetically impressive (but dreadfully inconvenient) large-feathered tail? A mechanistic explanation would have to do with the chemical nature of the pigments in the tail, the muscles that erect the tail during display, and the neural and hormonal control of these muscles and nerves. Even so, we would still probably wonder, "What is all of this good for?" This was a problem which received great attention by Charles Darwin and in attempting to explain it, he introduced a variant of natural selection called sexual selection.

Darwin's explanation still stands; it goes something like this: Males compete for the attention of their species' females. The *male's reproductive "strategy"* is to gain reproductive access to the female and exclude competing males' access. The *female's "strategy,"* on the other hand, is to evaluate the potential of different males and to select the fittest, since her contribution of an egg is so much more energy- and time-consuming than the male's investment in a single dose of sperm. Consequently, the male uses his tail to attract the female; the function of the display is to enhance the probability of reproductive success with the prized resource of a female.

Now, in the foregoing explanation, I have taken some liberties in oversimplifying the case. I have used terminology from contemporary sociobiology in re-describing Darwin's line of reasoning. The Darwin explanation, however, was the basis of modern sociobiology, as well as all of modern evolutionary theory for that matter; so perhaps I can be forgiven. Second, I have talked about "strategies," as if peacocks were rational economists weighing the consequences of alternative decisions. This teleological flavor may capture something of the old Aristotelian doctrine of final causes and explains why there is still, today, considerable intellectual resistance towards evolutionary-functional explanations. We are loathe to think that animals, and plants for that matter, think every time they display a biological adaptation. And even if they don't think, how can it be that a future event (reproductive success) can be a cause (Aristotelian or not) of something that is happening now?

Suppose there are two males attending to a female, and one of them is more attractive to the females than the other (perhaps because one has a slightly longer, shinier tail than the other). The female chooses, and the biologically fortunate male leaves offspring while the less attractive compatriot does not. To the extent that there is a genetic basis for the difference between males, the offspring in the next generation will have a higher probability of having the "better tail," will in turn be more successful than their generation's less florid males, and so on. Eventually, "florid tail" is a trait that becomes more prevalent and more pronounced. Today, then, we need not postulate that the male peacocks in the Philadelphia Zoo have any notion at all that their tail display is attractive (although that may be the case) any more than they have a historical understanding of how they derived the trait. The previously mentioned criticisms of evolutionary thought are not valid, because biological function exists by virtue of the past, not future events; it need not be reified in consciousness, just coded in the genes.

The second Aristotelian cause, the final cause, has thus assumed a modern form in biological reasoning. It has been transmuted into the concept of *function*. Behavior is not only caused by antecedent physiological mechanisms but is itself a cause of subsequent biological events, like reproduction. It has both biological causes and functions (effects). In the remainder of this talk, I would like to present some cases which will illustrate this kind of reciprocal relationship between behavior and physiology.

The case of the peacock is a general one. Males and females must cooperate to reproduce, but the specific patterns of the adaptation in the two sexes is often not the same. Sometimes, one observes behavior that seems quite bizarre. During the courtship of a male and female elephant seal, for example, the female will start emitting a call. That call is an excitement call which attracts other males who begin to fight over her. The function for her inciting the fight is to set up conditions that will offer her the fittest male to mate with. So her calling is not just a product of her hormones (the estrogen that her ovaries are putting out); it is a part of her "genetic strategy" for ensuring reproductive success. This sequence is best described as a chain: hormonal physiology first affects her behavior and then her behavior influences her subsequent reproductive performance.

In general, hormones may prepare the organism for reproduction but behavior often functions to trigger it. A mother bird won't feed her young unless she is in the correct endocrine condition. But neither will she feed the young unless the young behave by using their beaks and opening their mouths. Her behavior is a joint product of her internal physiology and of the external behavioral-derived stimuli impinging on her. The potency of maternal-releasing stimuli can even be observed in humans. One of the properties of young animals is that the ratio of eye size to head is quite a bit larger than in the adults of those species. A noted West Coast artist has, in fact, made a career out of the fact that pictures of children with big eyes evoke a sympathetic, and financially generous parental response from members of our species.

There are some interesting cases of the behavioral control of sexual capacity. Before she entered graduate school at Penn, Dr. Martha McClintock wrote an undergraduate thesis that showed women living in dormitories tend to synchronize each other's menstrual cycles. That is, women living together and having frequent social interaction tend to have their menses at the same time, month after month, even though logically, the chance of overlapping repeatedly are quite small.

Animals do this too. Some species of monkeys are nomadic; they are able to breed from February to June, but they don't; they all mate within a period of a few weeks (usually in March). This enables them to get the child-bearing over with and allows them to resume traveling again. And it is their behavioral interaction that recruits the more restricted period of intense breeding.

Ovulation is automatic in human women, but it is not automatic in rabbits, cats, minks. Indeed, most of the fur-bearing mammals require intensive stimulation. Have you ever heard female cats' persistent, seasonal meowing? This is a sign that the female is ready to ovulate. The neurological stimuli provided by the male's mating triggers ovulation.

There is also a negative effect on behavior on ovulation in mammals. Baby mammals suckle at the mother's nipples "in order to get" milk, but in the process they also inhibit her ovulation, thus reducing potential competition from a future litter.

There are cases of pregnancy being initiated by external behavioral events. Perhaps the most exotic involves a species of fish known as the Amazon Molly which consists only of

females. They are clones; the species reproduce by parthenogenesis. But members of this species cannot reproduce unless they mate. How can that be? The ovum of the Amazon Molly is not completely committed to parthenogenesis; it has to receive stimulation from the act of copulation. So the Amazon Molly borrows a male from a neighboring species. The males will court the Amazon Molly but do not contribute sperm; they contribute instead a stimulus that will cause the egg to start developing and dividing without a male's genetic input. Without that stimulus the egg will not parthenogenetically cleave.

The previous examples all demonstrate that behavior can control the release of hormones. In women and some monkeys, the overall timing of the ovarian cycle is modulated by social stimulation. Within the ovarian cycle, ovulation can be triggered by sexual stimulation (e.g. cats) or inhibited by nursing (most mammals). These behavior-physiology links are psychosomatic (or at least behavior-somatic) control systems that have evolved by virtue of their functional consequences.

Where one has function, however, there is always the possibility of dysfunction. Again, it was Darwin who pointed out that a physiological adaptation in a species at one time and place may be maladaptive in another.

To take a familiar example, a moth is so built that it flies toward light; normally this flight pattern is beneficial to this animal's nocturnal foraging. However, when presented with a light bulb, the unhappy insect will be drawn to the bulb, with lethal consequences.

Behavioral dysfunction is sometimes seen in humans. There are cases of false (or pseudo-) pregnancy, in which a woman's belly may be extended; the body may even secrete the hormones of pregnancy. This is most apt to happen in cases of severe stress, where the pressure to produce progeny is

Two male wildebeests perform a challenge ritual. (Drawings by Sarah Landry; reprinted by permission of publishers from Sociobiology *by Edward O. Wilson, Harvard University Press. ©1975 the President and Fellows of Harvard College.)*

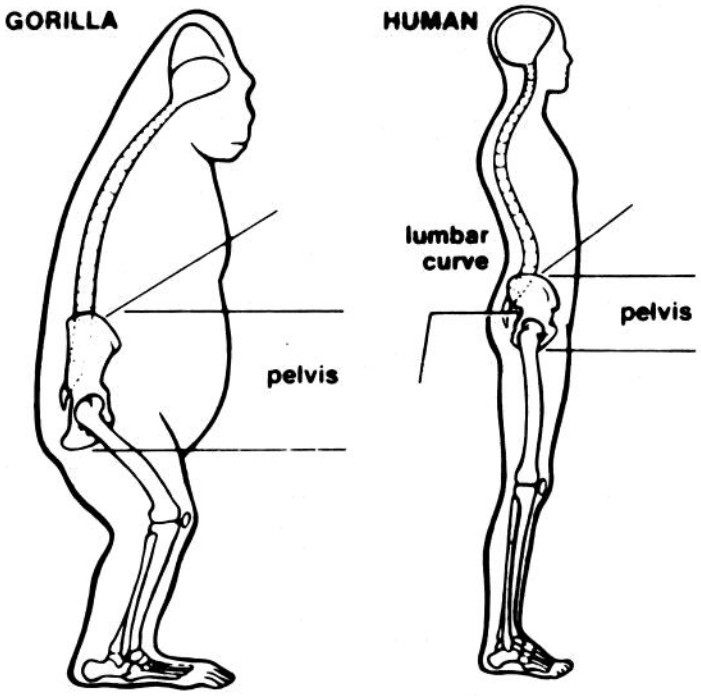
intense, as in the case of European royalty. Mary Tudor of England was so afflicted, as was the queen of Siberia and the American religious leader, Joanna Southwick.

The previous cases dealt with the role of behavior in controlling adult sexual physiology. The *development* of sexuality is under the control of behavior. Puberty is supposed to be an automatic physiological event; in fact, it is more like a thermostat. The brain has a very high threshold for hormone responsiveness. At puberty, this threshold is lowered. No one knows why, although it may be due to the influence of exteroceptive behavioral stimuli; whatever the precise mechanism, it occurs about the age of 11 or 12. The age of maturity has been going down in recent years. Girls become reproductive younger. What most people don't realize is that the age of puberty went up at the beginning of the 19th century; before the Industrial Revolution it was about as low as it is now.

One of the theories explaining the earlier onset of puberty is that the industrial age's development of cities and closer social proximity encouraged increased contact among individuals, and this increased social stimulation in turn accelerated the age of puberty. Now this social theory is still speculative in humans but is well documented in infrahuman animals. Female mice housed alone will become mature at 60 days of age. If they are placed with males they will become mature at approximately 40 days of age. And they don't even need the physical presence of males; the odor of adult males is enough. This makes good biophysical sense. If there is an available male around why not make use of that resource, become reproductive early, gain the competitive advantage and reproduce?

In mammals (including humans), the male is the "organizing" sex in the sense that the young male's testes produce hormones (androgens) which direct structure and physiology into the male pattern. If there are no androgens early in life, and you are a mammal, you will turn out to be a female. The female is really the basic sex while the male is an hormonally-induced alteration of the female. Not all animals, however, remain the same sex; some change sex during their life time. One of the most interesting species of this type is the Coral Reef fish. The social structure of the Coral Reef fish is one male and six females in his harem. If the male dies or is taken away by the experimenter, the top-ranking female becomes very aggressive in a couple of weeks. Her ovaries begin to change and eventually become transformed into testes. Within a month to six weeks, "she" turns into a "he" and, in fact, becomes the dominant male. The rest of the females comprise the harem. The behavioral conclusion from this case history is that a female has the potential to become a male. Normally, the male's social stimulation inhibits this potential, but if the stimulation is removed, the female metamorphoses into, and replaces, the absent male.

While this is an extreme case, it does illustrate the general point that behavior is not just the output of the system. It is not *just* the effect of some pattern of hormonal secretion. The behavior itself is functional; it is adaptive and it affects physiology. My thesis is that one must consider the effects of behavior—abnormal and normal—when dealing with the individual, whether you are physician, scientist, or observer of the beauty of the natural universe.



Compare the spinal columns of a gorilla and a modern human. The more extreme curve in the human spinal cord makes bipedalism possible.

Humankind Yesterday, Humankind Today

Alan Mann

I would like to explore some issues that are raised by the study of human evolution, issues that can have some interesting and important implications for the further understanding of ourselves. The first subject I would like to examine is the evolutionary development of our unique mode of locomotion, bipedalism, because it provides us with insights into the ways by which we have evolved and the kinds of systems that interact together. I would also like to consider the development of human social groups and indicate some patterns of modern social behavior that may continue to be influenced by our evolutionary history.

Bipedalism has long been recognized as one of the most important unique attributes of humans. Darwin, in *The Descent of Man* (1871), emphasized the development of erect posture in humans because he believed its appearance freed the hands from their use in locomotion and permitted our ancestors to begin to make and use tools. Although we are not certain when in time bipedalism originally developed and whether its evolution is as intimately associated with tool use as Darwin thought, there is overwhelming evidence for a bipedal human ancestor as early as 3.7 million years ago.

In modern humans, there are a whole series of modifications in our muscles and bones that enable us to move bipedally. These changes are especially well marked on the

pelvis, the thigh bone, the hip joint, knee and ankle joints, and the foot. Humans have a big toe that is not opposable: it is positioned up against the other four toes. The apes and monkeys have an opposable big toe that stands away from the other four toes; they are able to use it in much the way we are able to manipulate objects with our hands. Our foot is clearly a weight supporting foot, having evolved to permit all of the body weight to be carried by the legs. The human ankle joint is also specialized. The ankle joint in modern humans allows the foot to move primarily in a front to back orientation, that is, to bend it up and down, whereas the apes are far more able to rotate it so that the soles of the feet point inward, an advantage when they wish to climb trees.

There are also a number of rather marked changes in the human vertebral column. The vertebral column of the apes is gently curved, the column acting much like a beam from which the viscera is suspended and muscles attached. In human bipedal walking, to maintain balance, it is important that upper body weight be effectively positioned over the lower limb skeleton. This has led to the development of a very acute curve in the lower back area, in the lumbar region of the spinal column. While this is one of the features that makes bipedalism possible, it has also resulted in such lower back problems as muscle spasms (recent figures suggest that over 90% of Americans will have lower back muscle problems at one point or another in their adult lives) or, more seriously, difficulties with the intervertebral discs.

But is this not simply a cost that humans have to pay for being bipedal? Obviously, there must have been very strong evolutionary reasons for the development of bipedalism or else it would not have appeared. That may be true but our early bipedal ancestors were much smaller than we are. They were perhaps 3½ to 4½ feet tall and weighed about 60 to 80 lbs. Being shorter and smaller meant that the amount of stress placed on the lower back vertebrae was distinctly different from ours. Our early ancestors may not have had the same sorts of problems that we have with the lower back simply because there was less upper body weight resting on the lower back. Of course, these early bipeds probably didn't live as long a life as we do, and thus did not have many of the age-related problems which also play a role in modern human lower back difficulties. This suggests that we ought not to view evolution as progress: we are not necessarily developing into better and more efficient forms. We don't know why a larger body size developed in human evolution subsequent to the appearance of bipedalism, but there must have been strong evolutionary selective reasons, perhaps related to the increasing importance of hunting or to better nutrition. But increasing size came at a cost. Thus, there are changes in our evolution which are not always for the total betterment of the species.

Bidpedalism also influences the birth process. One of the marked differences between human females and females of other primate species is the ease by which birth takes place in these animals and the relative difficulty by which it takes place in humans. Much of this difficulty can be traced to changes in the pelvis. In modern humans, the total height of the pelvis has been compressed. This enables upper body weight to be efficiently transmitted from the spinal column-pelvic joint to the hip joint and then to the ground; in modern humans, the front of the boney birth canal and the back of the boney birth canal are more or less in the same plane (in the apes, the back of the boney birth canal is higher than the front of the boney birth canal). This change and the large brain of modern human infants has resulted in a process that is often very difficult. Again, this may not have always been so. Our early bipedal ancestors, in contrast to ourselves, had very small brains (perhaps one-third or one-quarter of ours in total volume) and therefore their infants had a much better chance of effectively passing through the changed architecture of the pelvic birth canal.

Here is another example of a trade-off in evolution. While the expansion of the brain in human evolution has provided the neurological basis for our ability to perform complex behavior and to make and use sophisticated tools, it has also presented

The broader and higher pelvis of a chimpanzee (left) compared to the more compressed pelvis of a human (on the right).

problems. Obviously, human evolution is a complex process, and the development of some biological features often does not have an always beneficial influence on other traits; this highlights the importance of understanding the relationships that have marked the evolutionary development of our species.

Other implications from the study of human evolution can be found by looking at the development of social behavior.

Fossil evidence now indicates that primates were living in social groups for at least 35 million years. (Our own zoological family, the Hominidae-humans and our immediate ancestors, probably appeared on the scene only about five or six million years ago.) Living in a social group is a very adaptive mechanism. Behavior is flexible because it's learned. As mammals, primates possess strong biological bases in the brain, the reproductive system, and the growth and development system, which permit young primates as they grow and develop to learn repertoires of behavior which are suitable to that particular environment.

How do young primates learn? By imitation and observation. As a young primate matures, it begins to associate in play groups of young animals of about the same age as itself. They play a lot, but they also spend an appreciable amount of time acting out behaviors they see adults perform, just as

human children do. By the time a young primate reaches adulthood, they have internalized a core of learned behaviors which serves as a foundation for their successful adaptation: they have learned how to exploit the environment, and they have learned how to interact with other members of their society.

In order for a primate society to be maintained over time as a coherent unit, animals must share a set of appropriate and predictable behaviors; the society would break down if one animal behaved towards another animal in a way that the other animal didn't understand and didn't know how to respond to. In most primate societies the behaviors of one generation are virtually the same as the behaviors of the next, although there are several examples where innovative behaviors have been observed being introduced and spreading to other members of the society. For example, Japanese primatologists observing a group of Japanese macaques (monkeys native to the Japanese islands; many of these groups are provisioned with a variety of foods, including potatoes), noted that one sub-adult female macaque was washing her potato off in the water. Over the next several years that behavior began to be imitated by other members of the group; after about a decade most of the animals in the group were washing their potatoes. It was the spread of the behavior that is most intriguing. Most of the animals who were adults when potato washing was first begun by the young female never picked up the behavior; the behavior was spread by younger animals who were growing up and imitating the behavior around them.

I think this example is a good illustration of an important point: there is no such thing as a generation gap in primate social groups. A primate society could simply not adapt and continue to survive if the behaviors were as changeable as they are in our own society. Primate societies are equipped with extraordinarily conservative behaviors because that is the only way they can continue to survive over time.

The size of the social group is important to this process. Because primates live in small social groups (the environment by and large is incapable of supporting a large number of animals, who would deplete resources in a given area very quickly) they have the opportunity of observing virtually all of the animals around them, and as they grow to maturity, to share with all the animals of the group appropriate behaviors.

In the earliest stages of human evolution, our ancestors were gatherers and hunters and their social group was also very small. Like our primate relatives, they led a non-settled way of life. Young humans, like young primates, learned appropriate behaviors through imitation and reinforcement. About 10,000 years ago, however, the situation changed dramatically. In what probably is one of the most important changes in all of human history, our ancestors became agriculturalists, and soon after, animal domesticators as well. This had profound effects.

Agriculture permitted humans to become settled and to begin living in large aggregations. The social group expanded dramatically and different segments within the social group also expanded and changed. With the development of agriculture began the development of specialization—in work, in crafts, in religion, in government—which marks our complex urban, technological society of today. Yet young humans still learn the same way their primate ancestors did 35 million years ago. Our children continue to learn their normative behaviors, their moral system, their ability to interact successfully with other members of society in the same way our primate relatives and ancestors did: by observing the behavior of adults around them and imitating and practicing those behaviors.

Unfortunately, in the changed social and economic system wrought by agriculture, this way of learning creates numerous problems, both within and between societies. In a very large complex society there are large numbers of different sub-groups, many having different origins and maintaining differences in their repertoire of appropriate behaviors. Because modern societies are so large we are incapable of seeing as we are growing up the total range of behaviors that are practiced in the society. Thus when we reach adulthood, we have a core of behaviors which we consider appropriate, and those in the sub-group in which we grew up also consider appropriate, but which may not be considered appropriate by other segments of society. This obviously leads to many difficulties in the ways by which all of us attempt to interact with others who view the world and how to behave in it somewhat differently than ourselves.

Technology has also affected us, particularly in facilitating increased communication between members of different human societies. Such communication only emphasizes the differences in the way different human societies live and behave. A

Western Modernization... An Enigma

Michael Zuckerman

For the better part of the past generation, social scientists have devoted much of their best effort to the study of modernization. Economists have examined growth and development. Demographers have detailed the demographic transition. Anthropologists have observed the dissolution of traditional societies. Sociologists have traced the myriad patterns of secularization, professionalization, bureaucratization, and rationalization. Yet for all their effort it seems scarcely an exaggeration to call modernization still the critical enigma of contemporary social science. Its substance grows more mysterious the more that it is studied, and its origin and evolution become more inexplicable.

Why was creativity mobilized in one culture and not in another, or at one time and not at another, or in one direction in one community and another in another? How are we to account for differential behaviors within these universal capacities and competences? And in particular, what are we to make of that one spectacular efflorescence of creativity in western Europe in the early modern era? It is all very well to assert that much of modernization arises from dispositions evident all around the world, but that merely makes more intriguing the failure of such widely-shared dispositions to achieve institutional expression earlier or elsewhere.

Philippe Ariès, in his book, *Centuries of Childhood*, analyzes the emergence of the early modern idea of childhood, but provides no causal interpretation of it. Ariès is perfectly prepared to view any number of subsequent developments—the rise of privacy, of the modern middle class nuclear family, of the cult of domesticity and motherhood, of differentiated juvenile institutions such as public schools, and more—as consequences of that emergence; but, aside from a momentary flirtation with demographic and hygienic factors which he himself rejects

good example is language. When we learn a foreign language, we learn rote translation of various words. But there is far more to learning and understanding how that language is used by a native speaker. Language permits humans to organize and develop their thoughts and to successfuly transmit these to other speakers of the language, but the total understanding of these thoughts and ideas will, by and large, be limited to those individuals who matured in that society. The word "Freiheit" (freedom) used by a German speaker in central Europe will have a very different connotation than the use of the word freedom used by an American. Freedom is an abstract word. What influences a person's views about what freedom means is a whole series of notions about what the society represents, how individuals live within the society, how individuals interact within the society, what their relationships are to the government, and a hundred other concepts.

What we learn is the product of the situation in which we mature. And because we are a modern complex urban society composed of many differences, we are all learning slightly different things. Real communication with others, either from different paths of our own society or from other societies, is very difficult because we so often do not understand what the behavior means from the other person's perspective.

Can we learn to do this? I don't know. At the present time much of what we see in the world is the dissolution of societies which include groups that possess differing notions of what is appropriate: Belgium and the Flemings and Walloons; Cyprus and the Greeks and Turks; Lebanon and the Moslems and Christians; Great Britain and the Welsh, and the Scots and the Irish; Canada and the French speakers and English speakers.

Unfortunately, these are merely a very short list of some examples. If we look around the world, we will find more societies in which there are major differences and conflicts between segments of the society than will be found societies in which groups are living together in harmony. I am suggesting that we view this major problem in the context and the perspective of primate evolution. It is a part of our evolutionary heritage as small group, non-settled gatherer/hunters, and it seems clear that our continued ability to survive as a species will depend on our success in dealing with this problem and learning to interact with others different from ourselves.

at once, he never addresses the question of causation in regard to the emergence itself. In his very silence he seems to be saying that the rage for order that expressed itself in the segregation of children (as vessels of innocence and irresponsibility) from the community (as the embodiment of corruption and polymorphous promiscuity) is in its own right a primary force, or a satisfactory stop to inquiry, which is in no more need of an explanation than, say, the mode of production might be in a Marxian analysis.

Certainly there is no present reason not to agree with him, or at least no plausible alternative. Parents began cherishing their children long before declining infant mortality rates made it psychologically safe to do so. If anything, it must make more sense to suppose that the new frame of mind conditioned the medical innovations that subsequently saved so many youthful lives than to hold that the demographic alterations that came later allowed parents to permit themselves to love their offspring several generations earlier. Similarly, nuclear families began setting themselves emotionally apart from wider kinship and community networks long before the industrial regime (so dear to the functionalists as a cause of the nucleation of the family) ever emerged on any significant scale. Again, it would be more plausible to infer that such prior privation of social life, such detachment of individuals and families from the once-dense matrix of the community, set the context for subsequent industrial development than to assume that eighteenth and nineteenth-century industry shaped sixteenth and seventeenth-century family life.

The simple fact of the matter is that Europe experienced no technological transformation of sufficient importance to account for Ariès' findings before the eighteenth century. Le Roy Ladurie has called France "truly . . . a 'pre-industrial society' " at least as late as 1700. Clarkson has declared England "an underdeveloped country until perhaps 1750." And more detailed accounts bear such judgments out.

In agriculture, for example, European cultivators managed no more than a "modest development" which "did not alter the pattern that had emerged during the late Middle Ages and the Renaissance." In industry there was "basic technical stagnation" throughout the sixteenth and seventeenth centuries even in textiles, the largest of all European industries.

In technology the sixteenth and seventeenth centuries saw little more than the assimilation of medieval accomplishments by "practical men" making "small technical advances." And in transportation and communication, men, materials, and messages traveled at about the same speeds in 1765 as they had in 1500. "Major change . . . did not occur" much before the nineteenth century.

Indeed, the net effect of all the alterations of material life in early modern Europe was so equivocal, and limited, that present day scholars are hard-pressed even to decide whether it was positive or negative in its impact on the population. Some authorities claim that per capita income in western Europe was slipping throughout the sixteenth century and on into the middle of the seventeenth, others say that the standard of living in Europe progressively declined well into the beginning of the eighteenth century while still others discern neither notable deterioration nor distinct improvement.

Yet in the midst of such economic immobility, European ambitions, anxieties, and assumptions changed at a remarkable rate. A modernization of mentality preceded the economic revolution which was its "final expression," and Ariès' *Centuries of Childhood* is but one of a numerous and immensely suggestive company of studies which have traced the change.

Keith Thomas's monumental *Religion and the Decline of Magic* is another. It exhibits a dramatic decline in the recourse to magic and a notable rise in reliance on religion during the seventeenth century, despite the fact that such developments were neither preceded nor accompanied by any increased human control over the environment. The prestige and practice

of the black arts diminished long before men achieved the medical and technological advances that are ordinarily taken to be essential to reduced resort to magic. Thomas consequently insists quite explicitly that we must seek an explanation for this transition in the domain of attitudes rather than technics; in a new belief in the efficacy of human effort that eventually made the decline of magic a condition of the advancement of rationality.

Other investigations, from the most imaginative and abstract to the most stolid and concrete, show similar patterns. J. Hajnal adduces indications that, in the early modern age, the population patterns of western Europe departed decisively from those prevalent elsewhere. Marriage ages rose to medians fully five and ten years later than those found in other parts of the world and in Europe itself before the seventeenth century. Unparalleled proportions of the populace never married at all.

Louis Henry, E. A. Wrigley, and a number of others demolish old sociological assumptions that traditional populations had unvaryingly high fertility levels until nineteenth-century industrialization, urbanization, and modernization led to secular declines. They demonstrate that such declines were more rural than urban and that, as early as the seventeenth century, voluntary control of fertility went forward without any "fundamental modernization of the underlying socio-economic structure" in towns and villages all through Europe. Summarizing these showings, Robert Wells explicitly rejects the sociological shibboleth that the demographic transition to modernity "resulted from the economic and social changes accompanying industrialization" and bluntly contends that that passage may be better comprehended in motivational terms that clearly antedate the advent of extensive mechanization. It was "only one manifestation of a major change in value orientation, a change which can conveniently be typified as a shift from a traditional to a modern world view."

W. G. Hoskins and Lewis Mumford advance an almost identical interpretation of the housing revolution which "destroyed the form of the medieval dwelling" and thereby set a new physical stage for domesticity in early modern England. Hoskins discounts as its causes such structural factors as price shifts and population growth. He demonstrates that the emerging form of the domestic interior—division into separate rooms and floors and provision of specialized furnishings for each room—was not a product of urbanization since it was as prevalent in rural areas as in urban ones. He holds flatly that "we must look for the cause of the Great Rebuilding in the filtering down to the mass of the population ... of a sense of privacy."

Natalie Z. Davis specifies some changes which hinged on this priority on domestic privacy, and she too finds them insufficiently explained by structural alterations. Tracing the rise of a new sensitivity to family strategy, a new conception of family identity, and a new concern for family order in early modern France, she refuses to relate such developments directly to their social contexts. "How can we talk of family strategies in the sixteenth and seventeenth centuries," she demands, "when even prosperous parents could not be sure of how many children they would bring up to adulthood? How can we talk of a heightened sense of family identity" when death and remarriage left all too often unclear "where the nuclear family began or ended?" Yet she shows that the "push toward planning" and "manipulation" gained ground steadily. If it is "assisted" by some of the social forces of the time, it was quite "in defiance of" others. In the final analysis, Davis simply asserts that "all this planning" was done with "a curious confidence" that it would be efficacious amid the "turns and twists" of early modern life.

In still other spheres a similarly inexplicable assurance came to the fore. In medicine, supernatural theories went out before effective techniques came in; In science, a "new faith in the potentialities of human initiative" enabled men such as Bacon and Descartes to stand "foremost" among those who "invented, instigated, and popularized" a "Western self-confidence" in the mastery of nature which far outran extant Western scientific achievement. In economic endeavor itself the evolution of a norm of work-discipline which Weber long ago labelled the Protestant Ethic preceded by decades and even centuries the evolution of commercial and industrial regimes that demanded such discipline.

In the emergence of such an economic ethic, and in the alteration of assumptions and aspirations more generally, we have what has been well-called a revolution before the revolution, a revolution in men's minds that preceded the revolution in machines and machinations.

If we would come to any comprehension of such times, we will have to fathom a collective psychic current—a social character or communal sensibility—that is crucial in alterations such as those of early modernization yet is creative and uncoerced rather than being merely an aspect of the cosmic determinism customarily associated with imputations of underlying social forces.

Human ideas have not always found widening audiences merely for having struck a responsive chord, but they sometimes have; and if the history of the origins of western European modernization yields up any lesson at all, it must surely be that we bear an almost awesome responsibility for what we dream and dread. The world we bequeath our great-grandchildren may as nearly be the one we envision most compellingly as the one we build most bulkily.

U Thant once said that "the central stupendous truth about developed economies today is that they can have—in anything but the shortest run—the kind of scale of resources they decide to have .... It is no longer resources that limit decisions. It is the decisions that make the resources." Yet if Ariès and Thomas and so many others are right, that may have been the case as much in early times as in our own time. Collaborative volition may be the human condition as much as it is the modern condition.

As Colin Turnbull stresses, "What is essential about humanity is not what man *is*, but what he *can* be ... Our nature is determined by what we do with that potential, not the other way round. And wherever there is choice, man ultimately is what he wants to be."

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