READINGS ON HUMAN BEHAVIOR

The Best of

SCIENCE '80-'86

Allen L. Hammond
Philip G. Zimbardo

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Scott, Foresman and Company
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PREFACE

Science is changing our world—sometimes dramatically and often in ways that for a long time are nearly invisible. Many of the most interesting and sometimes most important developments in science emerge so gradually that there is no news event—no startling discovery, no moment of breakthrough. Yet the impact on our society can be profound.

It is these stories about how things come to be, this larger picture of Science, that *Science* '80–'86 set out to convey. We wanted to understand science not only as an event but also as a mode of thought, a human endeavor, a process. We wanted to get beneath the headlines to see how scientists really lived, to share their process of discovery, to look at the world through their eyes. Scientists, after all, are people too—and if you really want to know what science is, you have to put scientists themselves under the microscope.

At the same time, most of the readers of *Science* '80–'86 were not scientists—they were people just like you. So we needed to translate not just the words that scientists use, sometimes we needed to use a different frame of reference entirely. While scientists are interested in the details of their subject and the details of their methods, readers are more likely to want to know how a new discovery fits in with what they already know, what it means to their world.

Thus we asked our writers to do more than report what their scientist-subjects said. Tell us, we said, or even better, show us what this area of science means in human terms. Help us gain some perspective. Why should we care about this subject? Why is it exciting or scary or fun?

Finally, we believed that, properly told, the pursuit and the substance of new ideas are inherently interesting, that they appeal to the same curiosity and hunger for novelty that led us as a species to ask questions about our universe in the first place. If it's not interesting, we said, then either it's not good science or it's not well written. We tried to insist on both.

New knowledge can be powerful and, particularly in the area of human behavior, provocative—as I think the reprinted articles in this volume demonstrate.

Allen L. Hammond

INTRODUCTION

When asked why he hadn't written home since leaving for college, one of my students replied: "In order to survive here I've learned not to write anything that does not get graded; there's just not enough time to do anything but *required* reading and writing." One of the major contributions of education to enriching our lives is teaching us the joys that come from reading and the pleasures that can attend writing. Thus, it is sad that these benefits get undercut by imposing extrinsic motivation on what should be the natural desires of every literate person. The problem worsens as each level of the educational enterprise tries to squeeze in as much information as possible in its relatively short time; to feed you all those ingredients assumed to be essential for your educational growth.

But what will happen on that magical day when you graduate and no longer are forced to do the required assignments? Will you then read and write all that you want to or will you end up with no intrinsic motivation left to do the job—just like the young toughs who used to bother uncle Nino.

> Nino, an immigrant shoemaker, was continually harassed by a bunch of neighborhood teenage "hoods," as he called them. Nothing he did could get them to stop spraying graffiti on his shop or shouting obscenities and taunting him and his customers. One day, in desperation, he offered the members of the gang $5.00 each if they could shout louder, more horrible, more creative taunts at him—no questions asked why he wanted them to do so. Naturally, they did so with wild abandon, applying much imagination to the task. The next day he offered another $2.00 each if they could outdo their previously impressive work. And sure enough, they did. When they returned on the third day, Nino said that he was short of cash but would give them a quarter each for shouting original obscenities and taunting him as before. "What do you think, we're crazy to work for peanuts? No way old man, get yourself some other suckers!" Nino wasn't bothered anymore once the young toughs refused to do their "required assignment" for small change.

Part of the continuing education program of every student in the world beyond college—or Nino's store—is doing things not because you must but because you want to, because you realize in choosing them that they are good for you. You will discover that you become a more interesting person by keeping informed about current events in society and the world around you; by, among other things, listening to National Public Radio and reading newspapers and magazines that provide in-depth coverage of local and world events. For people interested in special subjects there are many magazines that offer current perspectives on new developments in that field; *Psychology Today* is one obvious choice for those with a concern for psychology in their lives.

To acquaint you with the information that awaits you out there in the "real world" of the consumer of not-required-reading, we are reprinting here some of the most interesting articles on psychological topics that have appeared in the past few years in a superb magazine, *Science '80–'86*. These articles, written with a special flair by outstanding science writers and scientists and beautifully illustrated by talented artists, focus on psychological themes of considerable importance. They were selected primarily because we thought they would offer an interesting addition to your knowledge of psychology.

The 17 essays included here expand upon, further illuminate, or present alternative perspectives to information presented in the textbook, *Psychology and Life*, Twelfth Edition. A complete annotated listing of the articles follows.

By making these essays available to you in their original, colorful format, Scott, Foresman and I hope that you will begin to think about ways to extend your education beyond the confines of the classroom in your lifelong adventure of learning about psychology in your life.

Philip G. Zimbardo

Date	Article Author/Title

May 1981 — *James L. and Carol Grant Gould*
"The Instinct to Learn"

Although the behavioristic psychology of learning replaced earlier instinct doctrines, ethologists and biologists are fighting back with new evidence that animals, and maybe humans, are genetically programmed with instincts to learn certain things about their natural environment.

May 1980 — *Edwin Kiester, Jr.*
"Images of the Night"

Freud's theory of the psychodynamic function of dreaming is challenged by a new view that dreaming is simply the brain's attempt at interpreting in story form the random, confusing physiological signals from activated cells in its sleep center.

Jan. 1982 — *Dr. Richard Restak*
"Newborn Knowledge"

Within the first hours of birth babies display a remarkable talent for responding to and learning from their social environment; researchers are also surprised to discover how much infants know and can do.

March 1982 — *William Bennett and Joel Gurin*
"Do Diets Really Work?"

When the mind says "Diet," but the body says "Let's eat," which wins—when and why?

Sept. 1982 — *Melvin Konner*
"She and He"

Beyond the contributions of culture to gender differences are the effects of sex hormones on brain and behavior, most importantly, on aggression in males and nurturance in females.

Nov. 1985 — *Yvonne Baskin*
"The Way We Act"

The revolution in neuroscience is demanding that psychologists recognize the biochemical bases of behavior, cognitive functioning, and personality; "all power to the synapse!"

May 1983 — *Michael Watterlond*
"The Holy Ghost People"

The biblical justification for taking up poisonous serpents, handling fire, and drinking strychnine is bolstered by psychological and social factors operating among members of this fundamentalist Christian sect.

May 1984 — *Barbara Burke*
"Infanticide"

When babies are battered and killed in animal and human societies is the culprit a selfish gene that reflects biological imperatives to maximize the killer's reproductive success, rational economic calculations, or a male propensity for violence?

Oct. 1984 — *William Allman*
"Nice Guys Finish First"

Unexpected findings show that the best strategy for dealing with one's neighbors, business rivals, or international opponents is to use the cooperative-retaliative technology of tit for tat.

Date	Article Author/Title

June 1986 — *Perry Turner*
"The Shrinking of George"

Therapists from four different orientations (behavioral, cognitive, psychodynamic, and family therapy) offer solutions to the problems reported in the case study of George's unhappiness.

June 1986 — *Nikki Meredith*
"Testing the Talking Cure"

As millions of Americans spend billions of dollars annually on hundreds of different forms of psychotherapy, it is reasonable to ask not only does it work for the clients, but also what does it do for society.

May 1986 — *William F. Allman*
"Mindworks"

The computer has served as a metaphor for how the brain works, but new "connectionist" theories in psychology are trying to understand how the mind works by using the brain's neural circuits as models for the computer to simulate.

March 1985 — *Joseph Alper*
"The Roots of Morality"

The controversy over whether young children have the capacity for moral reasoning is fueled by new evidence that by age 2 they are actively trying to help others in distress and showing altruism as part of a complex prosocial response.

Dec. 1985 — *Ronnie Wacker*
"The Good Die Younger"

Survival of the elderly institutionalized in homes for the aged is found to depend in large part on their styles of responding to change and adversity; those more docile and accepting die sooner than those who complain and challenge the status quo.

April 1986 — *Duncan Maxwell Anderson*
"The Delicate Sex"

Does the evolutionary basis for infanticide found among female animals extend to sexual competitiveness among women—maybe?

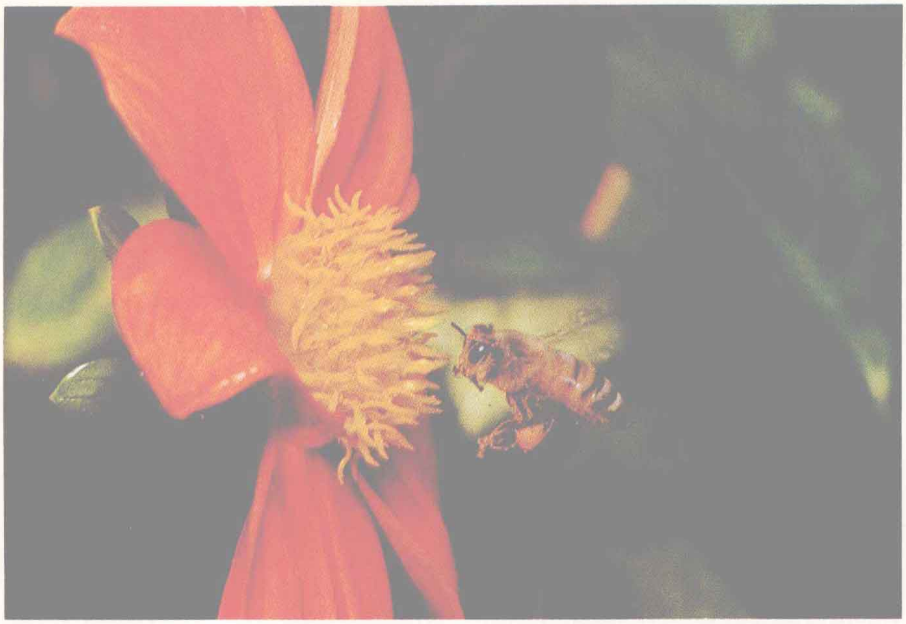
July 1986 — *Joseph Alper*
"Our Dual Memory"

Memory researchers have gone beyond studying recall of nonsense syllables to uncover the processes of mind and brain that have recast memory as the basis of our personality and intellect, the very foundation of our humanity.

May 1986 — *Joseph Alper*
"Depression at an Early Age"

Researchers disagree over the genetic versus environmental basis of the rise in depression, eating disorders, and suicide among teenagers but concur that these problems are reaching epidemic proportions.

CONTENTS



Treat Davidson/NAS/PR

THE INSTINCT TO LEARN

Birds do it, bees do it, perhaps even humans are programmed to acquire critical information at specific times.

by James L. and Carol Grant Gould

G. C. Kelley/NAS/PR

When a month-old human infant begins to smile, its world lights up. People reward these particular facial muscle movements with the things a baby prizes—kisses, hugs, eye contact, and more smiles. That first smile appears to be a powerful ingredient in the emotional glue that bonds parent to child. But scientists wonder whether that smile is merely a chance occurrence, which subsequently gets reinforced by tangible rewards, or an inexorable and predetermined process by which infants ingratiate themselves with their parents.

If this sounds like another chapter in the old nature/nurture controversy, it is—but a chapter with a difference. Ethologists, specialists in the mechanisms behind animal behavior, are taking a new look at old—and some new—evidence and are finding that even while skirmishing on a bloody battleground, the two camps of instinctive and learned behavior seem to be heading with stunning rapidity and inevitability toward an honorable truce.

Fortunately for the discord that keeps disciplines alive and fit, animal behavior may be approached from two vantage points. One of these sees instinct as the moving force behind behavior: Animals resemble automatons preordained by their genetic makeup to behave in prescribed ways. The other views animals as basically naive, passive creatures whose behavior is shaped, through the agency of punishment and reinforcement, by chance, experience, and environmental forces.

In the last few years, however, these two views have edged towards

Critical periods determine exactly when the honey bee learns the color of the pollen-rich dahlia and the white-crowned sparrow the song of his species.

reconciliation and, perhaps, eventual union. Case after case has come to light of environmentally influenced learning which is nonetheless rigidly controlled by genetic programming. Many animals, ethologists are convinced, survive through learning—but learning that is an integral part of their programming, learning as immutable and as stereotyped as the most instinctive of behavioral responses. Furthermore, neurobiologists are beginning to discover the nerve circuits responsible for the effects.

Plenty of scientists are still opposed to this new synthesis. The most vociferous are those who view the idea of programmed learning as a threat to humanity's treasured ideas of free will. However, it now appears that much of what we learn is forced upon us by innate drives and that even much of our "culture" is deeply rooted in biology.

As though this were not enough of a shock to our ingrained ideas of man's place in the universe, it looks as though the reverse is true, too: Man is not the sole, lofty proprietor of culture; "lower" animals—notably monkeys and birds—also have evolved various complicated ways of transferring environmentally learned information to others of their own kind.

The honey bee provides entrancing insights into the lengths to which nature goes in its effort to program learning. These little animals must learn a great many things about their world: what flowers yield nectar at what specific times of day, what their home hives look like under the changes of season and circumstance, where water is to be found.

But new work reveals that all this learning, though marvelous in its variety and complexity, is at the same time curiously constrained and machinelike. Certain things that bees learn well and easily, they can learn only at certain specific "critical periods." For example, they must relearn the appearance and location of their hives on their first flight out every morning; at no other time will this information register in the bee's brain. Beekeepers have known for centuries that if they move a hive at night the bees come and go effortlessly the next day. But if they move the hive even a few meters at any time after the foraging bees' first flight of the day, the animals are disoriented and confused. Only at this one time is the home-learning program turned on: Evidently this is nature's way of compensating for changing seasons and circumstances in an animal whose vision is so poor that its only means of locating the hive is by identifying the landmarks around it.

Since bees generally harvest nectar from one species of flower at a time, it seems clear that they must learn to recognize flower species individually. Karl von Frisch, the noted Austrian zoologist, found that bees can distinguish any color, from yellow to green and blue and into the ultraviolet. However, they learn the color of a flower only in the two seconds before they land on it. Von Frisch also discovered that bees can discriminate a single odor out of several hundred. Experimentation reveals that this remarkable ability is similarly constrained: Bees can learn odor only while they are actually standing on the flower. And finally, only as they are flying away can they memorize any notable landmarks there might be around the flower.

Learning then, at least for bees, has thus become specialized to the extent that specific cues can be learned only at specific times, and then only in specific contexts.

The bees' learning programs turn out to be restricted even further. Once the bits of knowledge that make up a behavior have been acquired, such as the location, color, odor, shape, and surrounding landmarks of a food source, together with the time it is likely to yield the most nectar, they form a coherent, holistic set. If a single component of the set is changed, the bee must learn the whole set over again.

In a very real sense, then, honey bees are carefully tuned learning machines. They learn just what they are programmed to learn, exactly when and under exactly the circumstances they are programmed to learn it. Though this seems fundamentally different from the sort of learning we are used to seeing in higher animals such as birds and mammals—and, of course, ourselves—careful research is uncovering more and more humbling similarities. Programmed memorization in vertebrates, though deceptively subtle, is widespread. The process by which many species of birds learn their often complex and highly species-specific songs is a compelling case in point.

Long before the birds begin to vocalize, their species' song is being learned, meticulously "taped" and stored somewhere in their memory banks. As the bird grows, the lengthening days of spring trigger the release of specific hormones in the males which in turn spur them to reproduce first the individual elements of syllables and later the sequence of the stored song. By a trial and error process the birds slowly learn to manipulate their vocal musculature to produce a match between their output and the recording in their brains. Once learned, the sequence becomes a hardwired motor program, so fixed and independent of feedback that if the bird is deafened his song production remains unaffected.

This prodigious feat of learning, even down to the regional dialects which some species have developed, can be looked at as the gradual un-

The parents will incubate even large black eggs instead of small speckled ones.

folding of automatic processes. Peter Marler of the Rockefeller University and his students, for instance, have determined that there are rigorous time constraints on the song learning. They have discovered that in the white-crowned sparrow the "taping" of the parental song can be done only between the chicks' 10th and 50th days. No amount of coaching either before or after this critical period will affect the young birds. If they hear the correct song during this time, they will be able to produce it themselves later (or, if females, to respond to it); if not, they will produce only crude, vaguely patterned vocalizations.

In addition, the white-crowned sparrow, though reared in nature in an auditory environment filled with the songs of other sparrows and songbirds with rich vocal repertoires, learns *only* the white-crowned sparrow song. Marler has recently been able to confirm that the parental song in another species—the swamp sparrow—contains key sounds that serve as auditory releasers, the cues that order the chicks' internal tape recorders to switch on. Ethologists refer to any simple signal from the outside world that triggers a complex series of actions in an animal as a releaser.

Here again, amazing feats of learning, particularly the sorts of learning that are crucial to the perpetuation of an animal's genes, are rigidly controlled by biology.

The kind of programmed learning that ethologists have studied most is imprinting, which calls to mind a picture of Konrad Lorenz leading a line of adoring goslings across a Bavarian meadow. Newborn animals that must be able to keep up with ever-moving parents —antelope and sheep, for example, as well as chicks and geese— must rapidly learn to recognize those parents if they are to survive. To achieve this noble aim evolution has built into these creatures an elegant learning routine. Young birds are driven to follow the parent out of the nest by an exodus call. Though the key element in the call varies from species to species—a particular repetition rate for one, a specific downward frequency sweep for another—it is always strikingly simple, and it invariably triggers the chicks' characteristic following response.

As the chicks follow the sound they begin memorizing the distinguishing characteristics of the parent, with two curious but powerful constraints. First, the physical act of following is essential: Chicks passively transported behind a calling model do not learn; in fact, barriers in a chick's path that force it to work harder speed and strengthen the imprinting. Second, the cues that the chick memorizes are also species-specific: One species will concentrate on the inflections and tone of the parent's voice but fail to recall physical appearance, while a closely related species memorizes minute details of physical appearance to the exclusion of sounds. In some species of mammals, the learning focuses almost entirely on individual odor. In each case, the critical period for imprinting lasts only a day or two. In this short but crucial period an ineradicable picture of the only individual who will feed and protect them is inscribed in the young animals' memories.

By contrast, when there is no advantage to the animal in learning specific details, the genes don't waste their efforts in programming them in. In that case, blindness to detail is equally curious and constrained. For instance, species of gulls that nest cheek by jowl are programmed to memorize the most minute details of their eggs' size and speckling and to spot at a glance any eggs which a careless neighbor might have added to their nest—eggs which to a human observer look identical in every respect. Herring gulls, on the other hand, nest far enough apart that they are unlikely ever to get their eggs confused with those of other pairs. As a result, they are unconscious of the appearance of their eggs. The parents will complacently continue to incubate even large black eggs that an experimenter substitutes for their small speckled ones. The herring gulls' insouciance, however, ends there: They recognize their chicks as individuals soon after hatching. By that time, their neighbors' youngsters are capable of wandering in. Rather than feed the genes of their neighbors, the parents recognize foreign chicks and often eat *them.*

The kittiwake gull, on the other hand, nests in narrow pockets on cliff faces, and so the possibility that a neighbor's chick will wander down the cliff into its nest is remote. As a result kittiwakes are not programmed to learn the appearance of either eggs or young, and even large black cormorant chicks may be substituted for the small, white, infant kittiwakes.

Simply from observing animals in action, ethologists have learned a great deal about the innate bases of behavior. Now, however, neurobiologists are even tracing the circuitry of many of the mechanisms that control some of these elements. The circuits responsible for simple motor programs, for example, have been located and mapped out on a cell-by-cell basis in some cases and isolated to a single ganglion in others.

A recent and crucial discovery is that the releasers imagined by ethologists are actually the so-called feature detectors that neurobiologists have been turning up in the auditory and visual systems. In recent years, neurobiologists have discovered that there are certain combinations of nerve cells, built into the eyes and brains of all creatures, that respond only to highly specific features: spots of a certain size, horizontal or vertical lines, and movement, for example. In case after case, the basic stimulus required to elicit an innate response in animals corresponds to one or a very simple combination of discrete features systematically sought out by these specialized cells in the visual system.

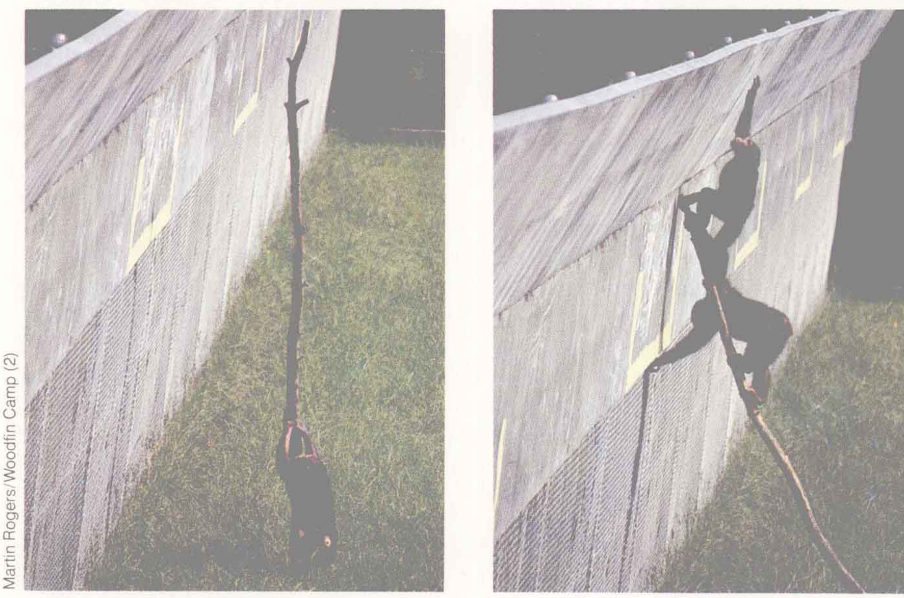
The parent herring gull, for instance, wears a single red spot near the tip of its lower bill, which it waves back and forth in front of its chicks when it has food for them. The baby gulls for their part peck at the waving spot which, in turn, causes the parent to release the food. First, Niko Tinbergen, the Dutch Nobel Prize winner and cofounder of the science of ethology with Lorenz and von Frisch, and later the American ethologist Jack Hailman have been able to show that the chicks are driven to peck not by the sight of their parent but at that swinging vertical bill with its red spot. The moving vertical line and the spot are the essential features that guide the chicks, which actually prefer a schematic, disembodied stimulus—a knitting needle with a spot, for example.

Though the use of two releasers to direct their pecking must greatly sharpen the specificity of the baby gulls' behavior, chicks do quickly learn to recognize their parents, and the mental pictures thus formed soon replace the crude releasers. Genes apparently build in releasers not only to trigger innate behavior but, more important, to direct the attention of animals to things they must learn flawlessly and immediately to survive.

Even some of what we know as culture has been shown to be partially rooted in programmed learning, or instinct. Many birds, for instance, mob or attack potential nest predators in force, and they do

ANIMALS ANIMALS/Alan G. Nelson

The oystercatcher employs a crafty technique to feed on underwater mussels: It stabs its bill through a mussel's open siphon and snips the muscle that clamps the shell tight. Other oystercatchers use two distinctly different techniques to get at the mussel meat.



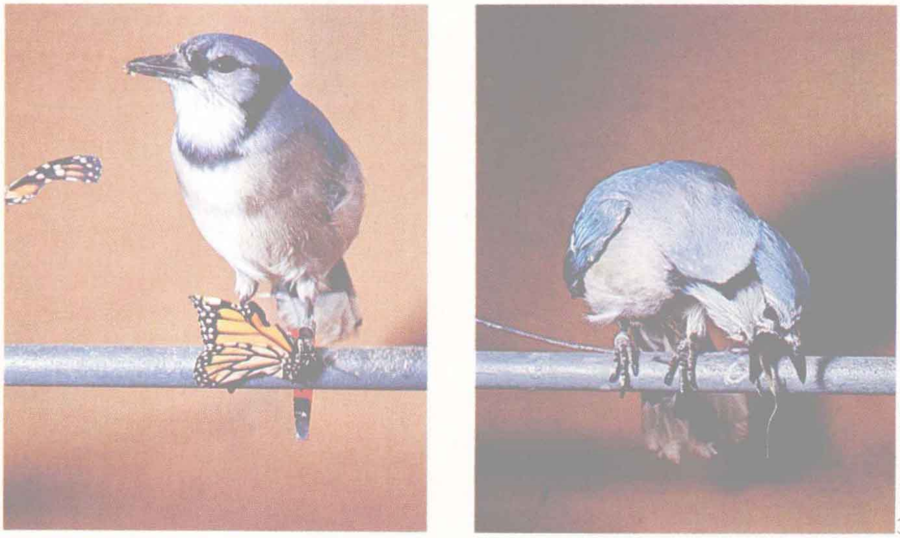
Martin Rogers/Woodfin Camp (2)

Poles were mere playthings for chimps, above, until one chimp braced his pole to use it for climbing. Then other chimps followed suit. In order to get its parent to feed it, the herring gull's chick, below, will instinctively peck at the red spot on the adult's bill.

Mary M. Thacher/Photo Researchers

J. Markham/Bruce Coleman Inc.

In a celebrated case of innovative behavior, blue tits in Britain learned to pierce the aluminum foil caps on milk bottles; the skill spread rapidly through the country.



Lincoln P. Brower (2)

One experience with a poisonous monarch teaches the blue jay, above, to avoid both monarch butterflies and mimics that look like monarchs. A Japanese macaque, below, finds food tastier when washed, inspiring other monkeys to copy its behavior.

ANIMALS ANIMALS/Esao Hashimoto

this generation after generation. But how could these birds innately know their enemies? In 1978 the German ethologist Eberhard Curio placed two cages of blackbirds on opposite sides of a hallway, so that they could see and hear each other. Between the two cages he installed a compartmented box, which allowed the occupants of one cage to see an object on their side but not the object on the other. Curio presented a stuffed owl, a familiar predator, on one side, and an innocuous foreign bird, the Australian honey guide, on the other. The birds that saw the owl went berserk with rage and tried to mob it through the bars of the cage. The birds on the other side, seeing only an unfamiliar animal and the enraged birds, began to mob the stuffed honey guide. Astonishingly, these birds then passed on this prejudice against honey guides through a chain of six blackbirds, all of which mobbed honey guides whenever they encountered one. Using the same technique, Curio has raised generations of birds whose great-great-grandparents were tricked into mobbing milk bottles and who consequently teach their young to do the same.

What instigates the birds—even birds raised in total isolation—to pay so much attention to one instance of mobbing that they pass the information on to their offspring as a sort of taboo, something so crucial to their survival that they never question if or why these predators must be attacked? The mobbing call, it turns out, serves as yet another releaser that switches on a learning routine.

Certain sounds in the mobbing calls are so similar among different species that they all profit from each other's experience. This is why we often see crows or other large birds being mobbed by many species of small birds at once. So deeply ingrained in the birds is this

After macaques learned that sweet potatoes are tastier when washed, the troop followed suit.

call that birds raised alone in the laboratory are able to recognize it, and the calls of one species serve to direct and release enemy-learning in others. Something as critical to an animal's survival as the recognition of enemies, then, even though its finer points must be learned and transmitted culturally, rests on a fail-safe basis of innately guided, programmed learning.

The striking food-avoidance phenomenon is also a good place to look for the kind of innately directed learning that is critical to survival. Many animals, including humans, will refuse to eat a novel substance which has previously made them ill. Once a blue jay has tasted one monarch butterfly, which as a caterpillar fills itself with milkweed's poisonous glycosides, it will sedulously avoid not only monarchs but also viceroys—monarch look-alikes that flaunt the monarchs' colors to cash in on their protective toxicity. This programmed avoidance is based on the sickness which must appear within a species-specific interval after an animal eats, and the subsequent food avoidance is equally strong even if the subject knows from experience that the effect has been artificially induced.

But what is the innate mechanism when one blue tit discovers how to pierce the foil caps of milk bottles left on doorsteps to reach the cream, and shortly afterwards blue tits all over England are doing the same thing? How are theories of genetic programming to be invoked when one young Japanese macaque monkey discovers that sweet potatoes and handfuls of grain gleaned from a sandy shore are tastier when washed off in the ocean, and the whole troop (except for an entrenched party of old dominant males) slowly follows suit? Surely these are examples pure and simple of the cultural transmission of knowledge that has

The cells that bring you the world

There was a time when the visual system was thought of as little more than a pair of cameras (the eyes), cables (the optic nerves), and television screens (the visual cortex of the brain). Nothing could be farther from the truth. We now know that the visual system is no mere passive network of wires but an elaborately organized and highly refined processing system that actively analyzes what we see, systematically exaggerating one aspect of the visual world, ignoring or discarding another.

The processing begins right in the retina. There the information from 130 million rods and cones is sifted, distorted, and combined to fit into the four or so million fibers that go to the brain. The retinas of higher vertebrates employ one layer of cells to sum up the outputs of the rod-and-cone receptors. The next layer of retinal cells compares the outputs of adjacent cells in the preceding tier. The result is what is known as a spot detector: One type of cell in the second layer signals the brain when its compare/contrast strategy discovers a bright field surrounded by darkness (corresponding to a bright spot in the world). Another class of cell in the same layer has the opposite preference and fires off when it encounters dark spots.

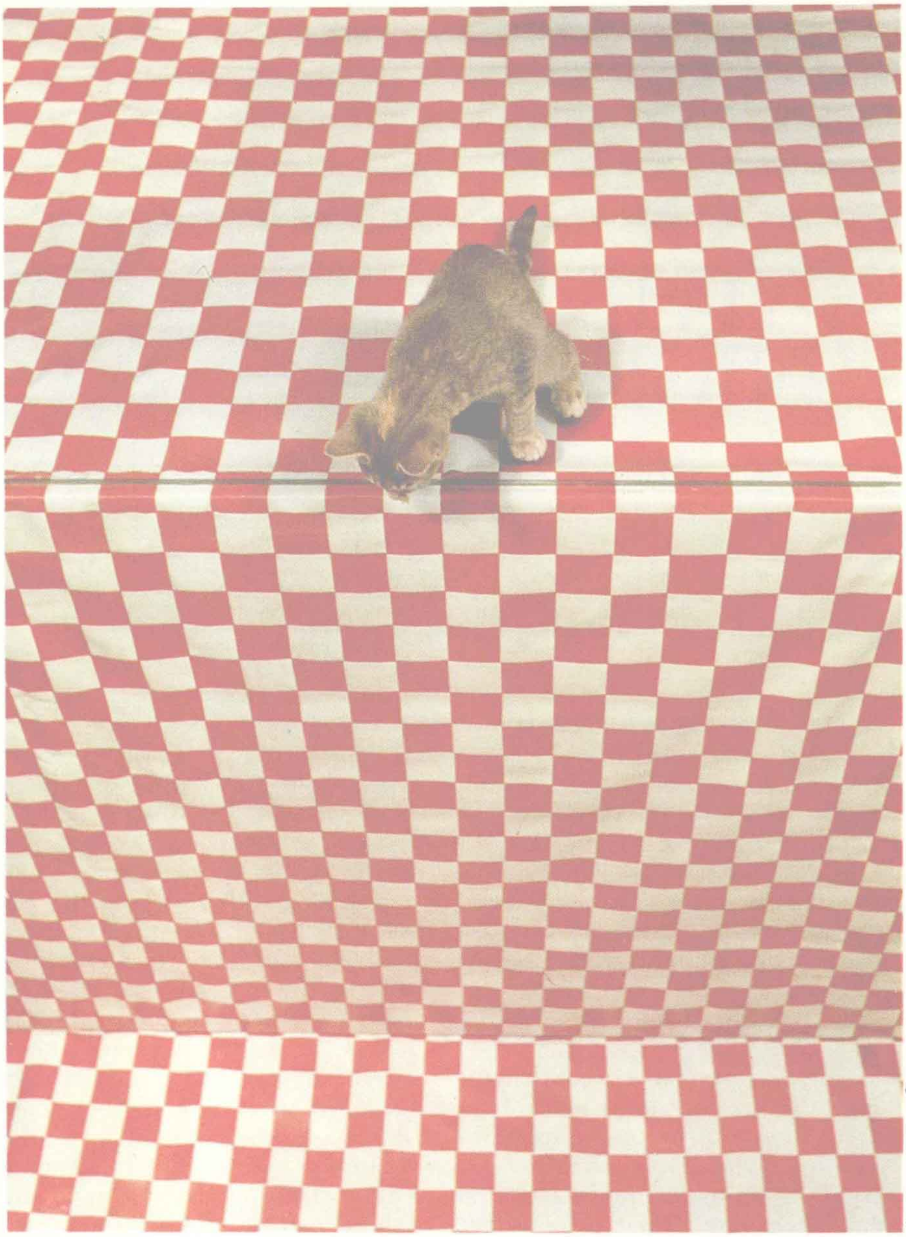
The next processing step takes this spot information and, operating on precisely the same comparison strategy, wires cells that are sensitive only to spots moving in particular directions at specific speeds. The output of these spot detector cells also provides the raw material from which an array of more sophisticated feature detectors sort for lines of each particular orientation. These feature detectors derive their name from their ability to register the presence or absence of one particular sort of stimulus in the environment. Building on these cells, the next layer of processing sorts for the speed and direction of moving lines, each cell with its own special preference. Other layers judge distance by comparing what the two eyes see.

The specific information that cells sort for in other retinal layers and visual areas of the brain is not yet understood. Research will probably reveal that these extremely complex feature detectors provide us with what we know as conscious visual experience. Our awareness of all this subconscious processing, along with the willful distortions and tricks it plays on us, comes from the phenomenon of optical illusions. When we experience an optical illusion, it is the result of a particular (and, in the world to which we evolved, useful) quirk in the visual mechanism.

Feature detectors are by no means restricted to the visual system. In birds and bats, for instance, specialized cells have been found that recognize many nuances in sound—locations, repetition rates, time intervals, and precise changes in pitch—that allow the creatures to form an auditory picture of the world.

There is every reason to suppose that our experience of the world is based on the results of this massive editing. Since neural circuits differ dramatically from species to species according to the needs of each, the world must look and sound different to bees, birds, cats, and people.

—J.L.G. and C.G.G.



Martin Rogers/Woodfin Camp

A kitten shies away from the edge of an apparent drop, which is actually covered with glass that the kitten can feel with its paw. Because the kitten has never been exposed to height, however, its caution must not be learned and can only be instinctual.

been environmentally gained.

Perhaps not. What the blue tits and the monkeys pass on to their colleagues may have an innate basis as well. The reason for this precocious behavior—and we say this guardedly—may be in a strong instinctive drive on the part of all animals to copy mindlessly certain special aspects of what they see going on around them. Chicks, for instance, peck at seeds their mother has been trained to select, apparently by watching her choices and copying them. In the case of many mammals, this drive is probably combined with an innate urge to experiment. The proclivity of young animals, particularly human children, to play with food, along with their distressing eagerness to put virtually anything into their mouths, lends support to the experimentation theory. Perhaps it is the young, too naive to know any better, who are destined by nature to be the primary source of cultural innovation. The more mature become the equally indispensable defenders of the faith, the vehicles of cultural transmission.

Patterns, then, however subtle, are beginning to emerge that unify the previously unrelated studies of instinct and learning. Virtually every case of learning in animals that has been analyzed so far depends in at least some rudimentary way on releasers that turn on the learning routine. And that routine is generally crucial to the perpetuation of the animal's genes.

Even the malleable learning we as humans pride ourselves on, then, may have ineradicable roots in genetic programming, although we may have difficulty identifying the programs, blind as we are to our own blindness. For example, you cannot keep a normal, healthy child from learning to talk. Even a child born deaf goes through the same babbling practice phase the hearing child does. Chimpanzees, by contrast, can be inveigled into mastering some sort of linguistic communications skills, but they really could not care less about language: The drive just is not there.

This view of human insight and creativity may be unromantic, minimizing as it does the revered role of self-awareness in our everyday lives, but the pursuit of this line of thinking could yield rich rewards, providing us with invaluable insights into our own intellectual development. The times we are most susceptible to particular sorts of input, for instance, may be more constrained than we like to think. The discovery of the sorts of cues or releasers that might turn on a drive to learn specific things could open up new ways of teaching and better methods for helping those who are culturally deprived. Best of all, analyzing and understanding those cues could greatly enrich our understanding of ourselves and of our place in the natural order. S

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