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Even at the age of four months, some infants eagerly reach toward a glittery object, while others respond to the novelty with frightened wails. Extremely shy or bold children tend to retain their temperaments throughout life, with intermediate individuals appearing to be more flexible.

Psychologists have long suspected that the shy-to-bold continuum—recognized as a fundamental axis of behavioral variation in humans—has a partly genetic basis. Recently, as reported in the January 12, 1996, issue of Nature Genetics, two laboratories found that individuals with different versions of a dopamine receptor gene tend to respond differently to questions such as “Do you often try new things just for fun and thrills?” on a personality test. Even siblings, who share a similar early environment and receive many of the same genes from their parents, tend to differ in their novelty-seeking behavior when they have different versions of this particular gene.

Whatever the genetic or developmental causes, only behavior that contributes to survival and reproduction will persist over evolutionary time. If a population includes shy and bold individuals, both are apt to be successful—and unsuccessful—in their own ways.

The psychological literature on personality is vast, but it almost never focuses on how personality affects survival and reproduction. In addition, psychologists often concentrate on people who suffer because their behavior is extreme—such as children who are incapacitated by shyness or whose boldness leads to reckless, even dangerous, behavior—with the goal of helping them to function better, while ignoring what may be the more adaptive middle range of behavior. Even animal behaviorists have traditionally studied differences between species or populations and neglected the nature of individual differences—the distinct personalities—within single populations.

Our own research into the subject began as a light-hearted collaboration. Anne had written an article on the nature of individual behavioral differences, in which she discussed the possibility that shyness and boldness exist in nonhuman species. David was conducting research on foraging in pumpkinseed sunfish (Lepomis gibbosus). With Kristine Coleman, then a graduate student, we decided to see if shyness and boldness are as conspicuous in pumpkinseeds as they are in humans and whether a fish’s “personality” has an effect on its fitness.

For our first experiment, we went to Cornell University’s experimental pond facility. At a pond populated by juvenile pumpkinseeds, we threw unbaited wire minnow traps into the water at sixteen-foot intervals along the shore. The juveniles scattered when the traps hit the water but soon returned in a cluster, seemingly drawn to explore the trap’s contours. After ten minutes we retrieved the traps and placed all the captured fish into buckets to be transported to laboratory aquariums. Then we swept the same shore with a net to catch fish that hadn’t entered the traps.

We reasoned that the traps were like the glittery novel objects that are waved in front of infants in psychology experiments. If a shy-bold continuum existed in pumpkinseed sunfish, then the bold individuals would enter the traps, while the shy individuals, hanging back or hiding in the vegetation, would be captured by the net. If subsequent tests also showed behavioral differences between the trapped and netted fish, that would signify personality differences in the natural population. (Realizing that differences between the two groups might also be caused by the capture method itself—
since the experience of being netted might be more stressful than the experience of being trapped—we also placed some of the trapped fish in the net and dragged them through the water, giving them the experience of both capture methods.)

We discovered that the average trapped fish began feeding five days sooner than the average netted fish. (Most fish refuse food for a period of days after being transported from their natural environment to aquariums.) A second experiment, which analyzed stomach contents, showed that prior to capture, trapped fish had eaten three times more zooplankton than had the seined fish. (Since zooplankton live in open water, feeding on them may be a riskier business than foraging in the shelter of aquatic plants.) A third experiment involved marking a group of newly captured fish and returning them immediately to the pond for observation. Trapped and netted fish mixed along the shore, but the netted fish tended to swim closer to other fish. During one observation period, for example, 21 percent of the netted fish and only 2 percent of the trapped fish were within three body lengths of another fish. There is safety in numbers, so the fish that entered the traps also took more risks while foraging in their natural environment.

Another student, Ted Dearyse, investigated adult pumpkinseeds in a larger lake. He discovered that when two marked fish were observed together, one almost invariably came closer to the diver than the other, providing an easy measure of relative boldness. Not only was this measure consistent for a single pair, but it also held across pairs. If A came closer than B, and B came closer than C, then A would come closer than C when they were observed together. These differences did not correlate with either size or sex; a 13-centimeter female might be bolder than an 18-centimeter male.

This willingness to approach the observer was accompanied by other behavior. In one studied pair, the shyer member never fed in the presence of the observer, even though its bolder partner often did. When the bold fish was captured and removed for three days, its shy companion spent the entire period under a submerged tree stump and did not emerge in the presence of an observer until the bold fish was returned. Ted attempted to capture the shy fish to observe the response of its bold partner. However, the shy fish had been caught once, for marking, at the beginning of the study, and it never allowed itself to be captured again! This example illustrates the potential costs and benefits of shyness and boldness in a natural environment. The shy fish lost many feeding opportunities, but if Ted had been a predator, the shy fish would have survived its bold friend and passed its genes to future generations.

Other investigators have obtained similar results for species as diverse as marmots, mantis shrimps, and octopuses. Shy and bold individuals exist throughout the animal kingdom. The costs and benefits of shyness and boldness are often easy to identify, but why do they so often balance, promoting a mix of personalities in one population?

Fitness often depends not only on how the individual behaves but also on how many other individuals behave in the same way. Choosing a safe habitat to feed in is generally better than choosing a risky one, but not always. In dense populations, individuals that prefer a risky but uncrowded habitat may do better than individuals that stay in a safe but crowded one. Population density is a great leveler of opportunity, which might explain a stable mix of personalities in all taxa, from mantis shrimps to humans.

What do our studies of foraging pumpkinseed sunfish tell us about their behavior in other situations, such as mating? Absolutely nothing. The forces of natural selection that promote individual differences for one activity can be completely different from those for other activities.

To look for personality traits tailored for particular situations, Kristine Coleman spent many hours lying in a glass-bottomed observation vessel that she maneuvered around
the pond by a system of cables and pulleys suspended above the water. From the standpoint of the fish—which frequently foraged within a few inches of the glass window—the vessel resembled a log or other large object, less threatening than a human observer in the water. As she cruised back and forth, Coleman recorded the behavior of individually marked fish for three-minute intervals.

She measured shyness and boldness in several ways. To simulate a nonthreatening situation, she placed a wad of aquatic plants in the water and recorded which fish were bold enough to approach and feed on the invertebrates living in the vegetation. To measure responses to a potentially threatening object, she floated on an air mattress toward individual fish and slowly extended a red-tipped stick toward them to see which fled and which approached or even nipped it. Later, she added largemouth bass (Micropterus salmoides) to the pond and observed the behavior of individual fish in the presence and absence of predators.

When Coleman compared the results of these experiments, she found that individual fish behaved consistently within single experiments but that the measures of shyness and boldness were not consistent across experiments. A fish that boldly nipped at the stick was no more likely to approach the ball of vegetation than a fish that fled from the stick. An individual's response to the addition of bass could be predicted from its response to the stick, but not from its response to the food.

The shy-bold continuum is thus as prominent in pumpkinseeds as in humans, but must be examined separately for every situation. This runs counter to psychologists' tendency to think of shyness and boldness as general personality traits, just as the capacity to learn was originally assumed to be a general ability, applicable to all kinds of problems. Not only were all individuals of a species expected to learn all things in the same way, but learning was also assumed to be fundamentally similar across species, justifying the use of rats and pigeons as "models" for the study of learning in humans. Gradually it was discovered that these assumptions were false. We now recognize that individuals have a number of specialized capacities that evolved to solve the major adaptive problems faced in ancestral environments. Likewise, species that evolved in different environments also learn differently. As our work with pumpkinseed sunfish has shown, that is precisely what we should expect of personality traits.

Added material

An inquisitive juvenile long-finned pompano investigates some red toenails in the shallow water off Saint John, U.S. Virgin Islands.

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