United States Trotting Association

Not Simply Symmetry

Does it really matter if the right ear is bigger than the left?

By ELIZABETH PENNISI

Want to understand bilateral symmetry? Stand naked in front of the mirror and imagine a line extending from your forehead down the center of your nose, through your navel, and between your legs. Right and left eyebrows, eyes, cheekbones, ears, shoulders, elbows, hips, thighs, knees, and feet match perfectly. Right?

Well, sort of, says John T. Manning, an evolutionary biologist at the University of Liverpool in England. Despite nature's best efforts, right never exactly matches left.

As researchers are finding out, the degree of mismatch can communicate potential shortcomings. New work suggests that some species, including humans, pay attention to these minor inconsistencies and may even pick sexual partners based on them — and not just because we have embraced Madison Avenue standards of beauty (part 2, next week).

Nature uses symmetry to signal the well-being of an individual, says Randy Thornhill, an evolutionary biologist at the University of New Mexico in Albuquerque.

He and about a dozen other researchers have recently taken a hard look at small deviations in symmetry: Is one side of the head slightly wider than the other? One kneecap a little broader? An ear a wee bit smaller? With steel calipers and multiple measurements, they are documenting subtle differences between right and left features in many kinds of organisms. These differences add up to an individual's so-called fluctuating asymmetry — fluctuating because there is no consistent trend for one side to be a particular way relative to the other, only for features to vary, Manning explains.

These fluctuations represent one of three kinds of deviations from nature's original design. Right- or left-handedness in animals exemplifies another kind, called antisymmetry. The third, directional asymmetry, results when development occurs on one side of the body but not the other, as in the case of the mammalian heart. The aberrations involved in fluctuating asymmetry are more random than these other two and can arise both during development and over the course of an animal's lifetime.

These mismatches seem to indicate well-being in a very broad sense. "It's really a measure of the developmental stability," Manning notes. Such stability reflects how well an individual's genes manifest themselves under various environmental conditions, especially stressful ones. If an organism's genetic makeup translates into a healthy, symmetrical individual even when confronted with disease, starvation, abnormal temperature, pollution, or parasites, then offspring should also prosper — and that's appealing to any creature's survival instincts.

"[Fluctuating asymmetry] potentially provides information about the interface between the environment and the genotype," agrees Therese A. Markow, a biologist at Arizona State University in Tempe. Nevertheless, she and others worry that some scientists are going too far too fast in promoting symmetry as a fitness indicator and, consequently, as a determinant of mate choice.

"One shouldn't be blinded by the simplicity of symmetry," says Craig Packer of the University of Minnesota in

Fluctuations that foil flowers

Beauty truly does exist in the eye of the beholder.

When they admire flowers, most people don't notice if one petal doesn't match the others. Insects, however, are less easy to please. Given a chance, bees, butterflies, and beetles snub all but the most perfect blossoms.

"Pollinating insects are actually able to perceive these differences," says Anders P. Møller, now at the University of Copenhagen in Denmark. "They prefer the symmetric ones."

But for good reason, he adds. While at Uppsala University in Sweden, he and Mats Eriksson compared nectar production and symmetry in individual plants. The more symmetrical the flower, the more nectar it produces and the better a food source it becomes for insects, they reported in the summer 1994 JOURNAL OF EVOLUTIONARY BIOLOGY. Also, the larger blooms proved more symmetrical.

Symmetry has a snowball effect on flowers' reproductive prospects. Flowers with lots of nectar get more frequent visits — and more pollen. Also, more of that pollen comes from symmetrical rather than asymmetrical plants. As a result, imperfect plants have less opportunity to be pollinated or to pollinate other flowers. With each passing generation, their genes are less well represented, Møller explains.

Furthermore, even when pollen from asymmetrical plants does find its way to another flower, the resulting seeds do not always survive. Møller determined this by taking pollen from both asymmetrical and symmetrical fireweed flowers and adding it to other fireweed blossoms. "Pollen from symmetrical flowers more often results in the production of seeds," he reports.

He suspects that whatever leads to the asymmetry in the first place causes the seed's development to go awry, creating errors that compromise its fitness. "[Asymmetry] has all sorts of consequences," he concludes.

— E. Pennisi

Minneapolis. "I think the real world is much more complicated."

Ecologists were among the first scientists to make use of asymmetry in studying animals. They monitored it to assess both the effects of environmental stresses, including pollution, on various organisms and the degree to which a population had adapted successfully to a particular environment.

In the past decade, studies of fruit flies, scorpion flies, and barn swallows have caused researchers to rethink fluctuating asymmetry. Anders P. Møller, an evolutionary biologist at the University of Copenhagen in Denmark, helped shift the focus from symmetry in populations to symmetry in members of those populations. "I was looking at asymmetry in individuals," Møller recalls.

Evolutionary biologists, animal behaviorists, even psychologists have since begun to adopt this perspective, examining symmetry's role in survival and performance. They are particularly curious about how this condition plays out in mate selection.

Many male organisms, from peacocks to horned beetles, sport an oversized, sometimes flamboyant tail, horn, chin, or other feature to tickle a potential mate's fancy — or so some early theorists proposed. In the early 1980s, forward-thinking biologists suggested that this flashiness indicated a healthy individual free of parasites. Other researchers have since come around to that view, assuming that even the wildest ornamental body part advertises its bearer's health and fitness. Logically, each individual, whether princess or platypus, should want a strong, healthy, fecund partner with good genes, they argue.

Because such traits signal one's overall fitness, they tend to become exaggerated through evolution, in a process called directional selection. Feathers become brighter or more numerous; males grow ever bigger, as if to say, "I don't have just good genes, I have GREAT genes." Human secondary sexual characteristics, such as large breasts in women or a prominent chin in men, fall into this category, so the theory goes.

For such sexually selected traits to evolve, however, their genes must skirt typical regulatory mechanisms. As they modify the body's normal blueprint, these genes may create internal stresses that can sidetrack developmental stability, Thornhill notes. Energy and resources are diverted away from the organism's other structures and functions.

Furthermore, the hormones that guide the development of these traits "are very bad and very costly 'drugs,'" Thornhill explains. They divert resources that the body would otherwise invest in symmetrical growth. "You expect more developmental errors [to occur] just because of this cost," he adds. Such errors can lead to ever more obvious fluctuations in symmetry. The hormones also tend to weaken the immune system, making the body more vulnerable to infection. Infections, in turn, can also affect development adversely.

If, after all that, an animal retains a good right-left match and manages to reach above-average stature, it must have really good gene karma. "Symmetry and size will honestly advertise the quality of the bearer of those traits," Thornhill says.

Through his experiments with barn swallows, Møller decoded symmetry's good-gene message early in his studies. When infected with a particular parasite as a chick, male barn swallows end up with one fork of their tails much shorter than the other — a trait that makes them less appealing to females, Møller reported in 1992. The females probably recognize uneven tails as evidence of parasitic infection and so generally prefer symmetrical ones.

Meanwhile, observations of scorpion flies in Japan led Thornhill in a similar direction. He discovered that females were drawn most strongly to the chemical sex attractants from males with the most symmetrical wings, even when the females couldn't see the wings. Those males also won the most fights and got the most food. He concluded that scorpion flies reproduce and survive better when they are symmetrical and that symmetry reflects other desirable qualities.

Manning examined the male peacock's ornamental train. As with barn swallows and scorpion flies, size counted for a lot, but so did symmetry. "[The peacock] is saying, 'I can develop this symmetrical tail despite the physiological cost,'" Thornhill points out.

In at least some cases, that boast is more than just talk, Manning and Liverpool colleague Louise Ockenden find, based on their study of asymmetry in young racehorses. The researchers evaluated 10 structural characteristics, some on the legs, others on the head, in 73 thoroughbreds, noting differences between the right and left sides. The larger the differences, the worse they predicted the horse would do in racing. Their assessments coincided closely with official predictions based on the animals' racing history, Manning says. He and Ockenden published their findings in the July 21, 1994 NATURE.

Symmetry in a horse's ears and eyes may improve its ability to judge distances. Symmetry in its legs may make it better able to speed down a course. "But probably asymmetry measures something much more important than mechanical constraints," he adds. Symmetrical equines may pound the turf faster because their lungs can take in more air, their digestive tracts work more efficiently, their metabolism is better, their bone structure is stronger, and all their senses are keener. "It's really a test of their genetic worth," Manning concludes.

Based on these and other reports, "the bottom line is that it's a highly significant pattern," Thornhill concludes.

But does this pattern hold for all species?

Because each lion bears a unique whisker-spot pattern, researchers working in the Serengeti Plain in Tanzania catalogued the faces of all the lions they studied. Packer then went back through 20 years of these records, noting the degree of asymmetry, sex, and age of the animals. As expected, males with more lopsided faces tended to die younger than males with even patterns. But the trend in the females was the reverse, he reported in 1993.

Likewise, Markow, who pioneered studies of the link between asymmetry and mate choice with her work in one species of fruit fly, doesn't always get consistent results. She has evaluated this link in three more fruit fly species and observed a connection in just one.

Even when an organism is attracted to a symmetrical mate, the allure may not stem from symmetry's connection to fitness, note John P. Swaddle and Innes C. Cuthill of the University of Bristol in England. Other work had demonstrated that female zebra finches had a yen for males wearing specific colored bands on their legs. Swaddle and Cuthill went one step further, dressing males in two orange and two green leg bands but arranging the bands differently on each. Thus, some males sported symmetrical color patterns while others did not. These bands had neither evolved nor resulted from developmental processes, yet the females favored the symmetrical patterns, the Bristol researchers reported in the Jan. 13, 1994 NATURE.

Møller has noted a few unexpected findings in the preferences of female barn swallows. Females seeking a mate should prefer not just a partner with good genes, but one that does his full share of the work in caring for the young. With their perfect tails, symmetrical males should outstrip less symmetrical males in bringing food back to the nest.

Actually, the less-than-symmetrical males prove better providers than their rivals, Møller reported in the summer 1994 BEHAVIORAL ECOLOGY. However, 2 weeks after the baby birds hatched, everything evened out, with offspring of both types of males reaching the same stature. It appears that hard-working moms make up for slacker dads. Feminists might wonder, though, what females see in those symmetrical tails. □

Next week: What symmetry says about people and what simulations say about symmetry.