Nearly every creature in the animal kingdom prefers using one paw over the other for certain tasks. But why did such an odd trait ever evolve, asks left-hander **Nora Schultz**

Southpaws

HANDICRAFTS were never my strong point at school. For each project I attempted, I'd struggle with tools and techniques that didn't suit a left-hander like me, which often made me wonder why humans are wired to prefer using one side of the body over the other. Apart from a few wrist aches, though, my handedness hasn't been too much of a burden. Contrast this with the bad luck of a toad that fails to jump away from a snake approaching from its right, just because its right eye is much worse at spotting the danger than its left. Clearly, such asymmetry can have fatal consequences.

All the more perplexing, then, that creatures across the animal kingdom – including mammals, birds, fish and invertebrates – prefer to use one paw, eye or even antenna for certain tasks, even though they may then be let down in crucial situations by their weaker side.

The cause of this trait, called lateralisation, is fairly simple: one side of the brain, which generally controls the opposite side of the body, is more dominant than the other when processing certain tasks. Why would animal brains ever have evolved a characteristic that seems to put them in harm's way? Armed with a spate of ingenious cognitive tests, a group of animal psychologists think they've finally found the answer, in the shape of some previously overlooked benefits to a lopsided brain-body connection.

Not before time. Up until the not-too-distant past, it had been broadly assumed that handedness was a uniquely human trait that evolved as a by-product of our amazing capacity for language. "This unique skill depends predominantly on the left hemisphere, so everybody thought language and lateralisation were tied up," explains Richard Andrew of the University of Sussex, UK.

This notion rapidly fell apart as researchers starting spotting evidence of lateralisation in all sorts of animals. Back in the 1970s, Lesley Rogers, now at the University of New England in Armidale, New South Wales, Australia, was studying memory and learning in chicks. She had been injecting cycloheximide into the chicks' brains to stop them learning how to spot grains of food among distracting pebbles, but found the chemical only worked when applied to the left hemisphere. That strongly suggested that the right side of a chick's brain played little or no role in learning such behaviours – compelling evidence that the different sides of the animal's brain perform different tasks (*Pharmacology, Biochemistry and Behavior*, vol 10, p 679). "Injecting it on the right side had absolutely no effect. And that was the initial discovery of lateralisation in the chick, at a time when everybody thought it was unique in humans," she says.

Similar evidence appeared in songbirds and rats around the same time, and since then, researchers have built up an impressive catalogue of animal lateralisation. Sometimes it's as simple as a preference for a single paw or foot – primates, cats and even parrots fall into this category. In other cases, lateralisation appears in more general patterns of behaviour.

The left side of most vertebrate brains seems to process and control feeding, for example. Since the left hemisphere processes input from the right side of the body, that means animals as diverse as fish, toads and birds are more likely to attack prey or food items if they view them with their right eye. Even humpback whales prefer to use the right side of their jaws to scrape up sand eels from the ocean floor. Some more exotic recent examples of animal lateralisation include elephants with marked preferences for which direction they swing their trunk for feeding or sand spraying, and honeybees whose right antenna is more sensitive to odours.

Like humans, many primates are either right or left-handed

There are no hard-and-fast rules, however. Many fish, for example, consistently turn in the same direction when faced with a predator, apparently so that they can use a specific eye and brain hemisphere to deal with the situation, but a study of 16 different species found that the preferred direction varied between species, no matter how closely related they were (*Laterality*, vol 5, p 269). Similarly, parrots can be left-footed, right-footed or ambidextrous. The side preference can even differ within a species according to

RUNGROJ YONGRIT/EPA/CORBIS

gender: tomcats tend to fish tuna out of a jar with their left paw, while females prefer their right paw.

Despite such diversity, we can't rule out the possibility that lateralisation was passed down from a single common ancestor. Lateralisation is caused by the way the brain is organised, with certain regions predisposed to handle certain aspects of cognition. Generally, only one side of the brain will contain the region that handles a given aspect of cognition. So a preference for a particular side therefore depends on which of these regions are typically involved in the task. Since there might be multiple ways of performing a task, each using different regions of the brain, a preference for one side may just be a symptom of the chosen cognitive strategy. "Different individuals or species may be using different cognitive approaches to deal with similar problems and this affects which side of the brain has the upper hand," says Giorgio Vallortigara at the University of Trento in Italy. In that case, the brain organisation underlying lateralisation may still have arisen in early ancestors, even if specific side preferences have shifted over the years.

What, then, ultimately determines the direction and level of lateralisation in an individual? Genetics will certainly play a ›

"Animals as diverse as fish, toads and birds are more likely to attack prey viewed with their right eye"

IS YOUR PET A SOUTHPAW?

Try these tests to see if your furry, feathered or scaly friends prefer to use their left or right appendages for certain tasks – and what this reveals about their behaviour.

Dogs: See if Fido wags his tail to his left or right. If he's like most dogs, furious wagging to the right means he is relaxed and ready to approach whatever he sees; if he wags to the left he might prefer to withdraw.

Cats and rodents: Give your cat, rat or hamster a jar with a tasty treat and see which paw they use to try and extract it. If your pet is a cat, expect toms to use their left paws and the females to use their right.

Parrots and other dextrous birds: This is an easy one. "Anything they are interested in they will pick up with their dominant foot," says Culum Brown at Macquarie University in Sydney, Australia. Watch out for odd combinations of lateralised behaviours too. Unlike most birds which view the objects they hold with the eye on the same side, the Australian galah manages to pull off a cross-over number, using the eye on the opposite side.

Fish: Place an unfamiliar object in the centre of your fish tank and record if your fish go around it clockwise or anticlockwise, indicating their eye preference. Be aware, though that the preferred eye might change depending on whether the object is disturbing or attractive and whether your fish are bold or shy (*Animal Behaviour*, vol 74, p 231).

Reptiles and amphibians: Move a food morsel into your pet's field of view from either the left or right side and watch which direction elicits more or quicker catches. For most species tested so far, the right side appears to be the favourite.

Horses: Chances are that your horse has already been trained to be handled from the left side. Recent research suggests that horses prefer to use their left eye for assessment and evaluation of their surroundings regardless of such training. Yet horses are also likely to react more strongly to alarming sights they see with the left eye too, which leads Lesley Rogers and Nicole Austin at the University of New England in Armidale, New South Wales, Australia, to propose that it might be worth exploring if they should actually be trained from the right instead.

Tomcats generally prefer using their left paw to fish for food

KENNETH BENGTSSON/NATURBILD/CORBIS

part, but environmental factors can have an impact too. Rogers, for example, has found that a chick's bias depends on whether its egg was exposed to light before hatching – if they are kept in the dark during incubation, neither hemisphere becomes particularly dominant.

Fortunately, this observation allowed Rogers to test the possible advantages of a brain bias in 2004, by hatching broods with either strong or weak lateralisation. She had the notion that a lateralised brain, with each hemisphere processing input from a different eye, might help chicks to do two tasks simultaneously – watching out for predators with one eye while searching for food with the other. So she studied the behaviour of the two groups of chicks presented with a smattering of grains among small pebbles under the threatening silhouette of a fake predator bird flying overhead.

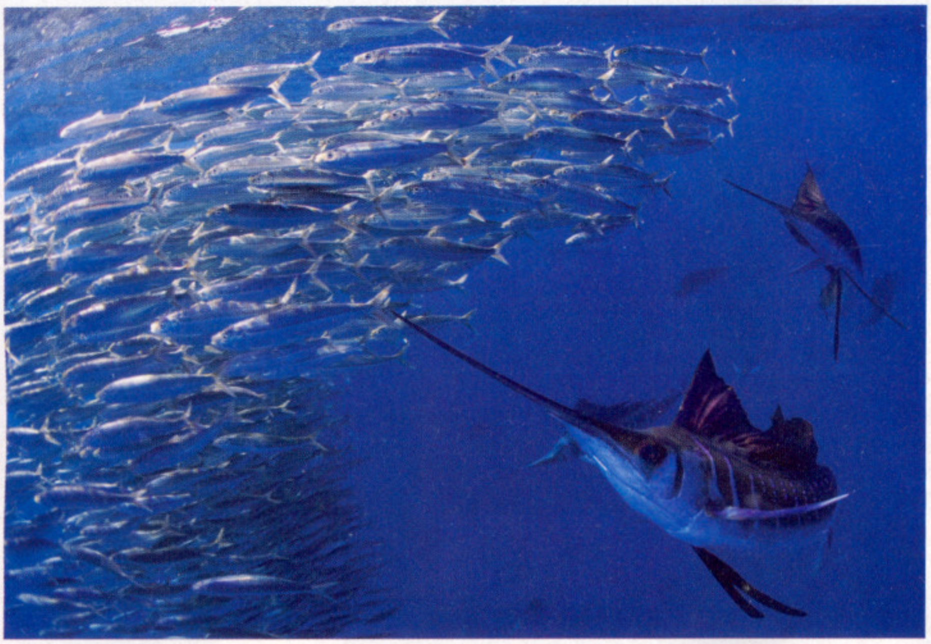
As expected, the chicks incubated in the light looked for grains mainly with their right eye, while using the left eye to check out the predator. The chicks incubated in the dark, however, had trouble deciding where to look. They had no preferred eye for foraging or checking on the predator and became so distracted by the challenge of multitasking that they actually became less likely to detect the predator. And their ability to spot the grain declined over the course of the experiment (*Proceedings of the Royal Society B*, vol 271, p S420).

Parallel processors

Similar results probably hold true for many other animals. Angelo Bisazza at the University of Padua in Italy, for example, has studied goldbelly topminnows with different levels of brain lateralisation. With the threat of a predator looming over them, the strongly lateralised fish caught tasty brine shrimp twice as fast as weakly lateralised ones.

Assigning different jobs to different brain halves may be especially advantageous for animals such as birds and fish, whose eyes are placed on the side of their heads so that there is little overlap between the two visual fields. Processing input from each side separately, with different tasks in mind, would seem a natural way to distribute their resources. "So functional left-right asymmetries are much more relevant in everyday behaviour for a fish or a bird than, for example, for a primate with frontal eyes," says Bisazza.

Nevertheless, there are many other cases of lateralisation that can't be explained this way.



PAUL NICKLEN/NGS

Most fish in a species turn the same way when facing danger

What about animals that prefer to use a specific paw or foot for almost all tasks, for example? This led Maria Magat and Culum Brown at Macquarie University in Sydney, Australia, to wonder if there were a more general cognitive advantage that might apply to any lateralised animal. To investigate, they turned to parrots, which, like humans, can be either strongly right or left-footed or totally ambidextrous.

The parrots were given the intellectually demanding task of raising a tempting snack dangling on a string up to their beaks, using a coordinated combination of their claws and beak to pull the string. The results, published last year, showed that the parrots with the strongest foot preferences solved the problem far more quickly than their ambidextrous peers (*Proceedings of the Royal Society B*, vol 276, p 4155).

Why lateralisation would lead to this general cognitive advantage is not clear, though multitasking is probably still involved. Lateralisation allows the brain to channel information from multiple sources and process different parts of complex tasks in different hemispheres so that each can be processed separately at a quicker rate. One side of the brain, for example, may process well-established, routine "housekeeping" tasks while the other side detects and processes unexpected stimuli and challenges.

Yet in all these cases, it is the strength of lateralisation, rather than the direction, that confers the benefits, raising another puzzling question: why do most animals within a species prefer the same side, making their behaviour extremely predictable to predators, prey and competitors alike? And why are there always a few oddballs, like me, who are wired differently from the rest of the population?

Vallortigara and his colleague Stefano Ghirlanda at Stockholm University in Sweden, have found an answer in game theory. They have constructed mathematical models which show that every animal gets the best deal in a group that's made up of many individuals with the same lateralisation, plus a small proportion of outsiders like myself.

They considered a group of individuals constantly faced with the threat of predators – fish swimming in a sea with sharks, for example. In these situations, you might think that there would be safety in numbers – your risk of being caught reduces as you surround yourself with ever more potential victims. So it would make sense for each individual fish to stay in sync with the crowd, turning together in the face of a predator.

Conversely, however, Vallortigara supposed that as long as most fish do exactly this, it might pay for a very small proportion of group members to escape the other way. They would benefit by running off in the direction that the predator is not expecting. However, this advantage only holds as long as this alternative strategy remains rare and unpredictable. The team's models showed that the most stable grouping in the face of various evolutionary pressures is one where a large majority are lateralised in one direction, accompanied by a small minority of individuals that buck the trend (*Proceedings of the Royal Society B*, vol 271, p 853).

"Human left-handers are more likely to survive potentially fatal hand-to-hand fights"

Surprise attacks

Similar trade-offs between majority and minority preferences may exist within a population too, explaining the varied patterns of lateralisation in many species. Numerous studies have found, for example, that both cooperative behaviours such as courtship displays or parent-offspring interactions and aggression among peers tend to be lateralised across populations in creatures as diverse as lizards, wading birds, Siamese fighting fish and primates. Here, the balance between left and right preferences would depend on two competing factors – in this case, the benefit of being able to react in kind during cooperation, and conversely, the ability to go against expectations in antagonistic interactions and launch an attack from an unexpected quarter (*Philosophical Transactions of the Royal Society B*, vol 364, p 861).

Perhaps this can partly explain the existence of left-handers in human societies. Numerous studies have found that left-handers have an advantage in many sports involving a direct opponent, such as tennis or boxing, and the advantages may run to more serious encounters: many sports are forms of ritualised combat, after all. Charlotte Faurie and Michel Raymond at the University of Montpellier in France compared eight unindustrialised indigenous societies and found that those with the highest number of homicides also had the most left-handed people, suggesting that lefties really are more likely to survive hand-to-hand fights (*Proceedings of the Royal Society B*, vol 272, p 25).

All this is good news for me, a left-hander in a right-handed world. I survived the complex cognitive challenges of higher education thanks to my highly lateralised brain, and with a good set of left-handed appliances, I don't even get wrist ache anymore. Fair enough, my drawing and needlework still leave a lot to be desired, but I take comfort in the knowledge that should anyone tease me about it, I might just be able to pull off a surprise attack with my left hand. ■

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