When the brood sings along

The songbird has been found to learn best the songs of its own kind

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The songbird is unique among animals in the capacity of its voice-box and its ability to repeat sequences of tones that follow patterns. The study of how this comes about could help us understand how the human baby learns to speak, both in its parental dialect as well as another language.

Studies have shown that birdsong is not innate but is learnt by the fledgling, usually from its father. Birds do, however, learn to produce or to respond to songs of closely related species of birds. David Wheatcroft and Anna Qvarnström of the department of ecology and genetics, Uppsala University, Sweden, describe in the journal, *Nature Ecology and Evolution*, a study that shows that genetics plays a major role in the final repertoire or musical preference of the feathered singer.

Humans are capable of speech, oral and musical communication because of the apparatus in the voice-box and the mobility of the oral cavity, on one part, and the intelligence to connect sounds with meaning and grammatical structure, on the other. Even with these prerequisites, however, just how languages evolve and why most languages have similarity in structures has not been understood.

David Wheatcroft

Anna Qvarnström

Many birds have a voice-box structure called the syrinx, the equivalent of the human larynx, which is placed deep within the birds' throat with the capacity to produce more than one tone at a time. Birds make good use of this organ for endless chatter, individually, in pairs or in groups, and can belt out a clutch of different tones in long sequences. Studies have shown that the sequences are not random and each species of bird uses specific patterns for aspects of communication. Messages passed could be mating calls, aggression, keeping the flock together, encouraging the young to feed and so on. Young birds learn while still in the nest from adult "tutors", usually the male parent. There is also evidence that birds can again be trained to produce different tone sequences by a trainer bird, or even a recording, over a few days.

While conveying information would be one function of birdsong ability, another is its role in species identity. The birdsong, the fledgling hears just before hatching and while in the nest would be the language the bird will later chirp or recognise. This would then help the bird find a mate or be found as a mate, to keep the genetic line within the species. There are, however, instances of "song mixing" and confusing of mating calls of closely related species, which may be a result of "cross learning". The Uppsala University researchers hence examined whether social experience was indeed the "main determinant of early song discrimination". Many other factors interplay, the paper says, like the maternal effect of deposition of the hormone, testosterone in the yolk, which could affect the development of the brain cells, which are involved in song discrimination. And then, the genetic background could be a factor.

The researchers hence tested for the relative effect of the different factors by assessing the song discrimination in nestlings that had been blocked out from sounds made by the same species even while in the embryo, in the egg, or exposed to the songs of related species and in birds that were of mixed genetic heritage, by a cross of closely related species. The collared flycatcher and the pied flycatcher are two closely related songbirds that are found in the Baltic island of Öland. The songs of the two species have different characteristic features, the paper says, and these differences serve to regulate mating patterns. Nevertheless, about six per cent of the pairs the birds form have one adult of each species. Both species are believed to learn songs from what they hear and it is possible that a nestling is affected by the songs of a nearby distant relative!

Among the Baltic flycatchers, the paper says, fledglings learn to make out the songs of their species by the ninth day after hatching. And then, the hearing apparatus in the embryo develops just before hatching. Using this information, the researchers could manipulate the whole early hearing experience of fledglings by swapping the eggs in the nests of the two species. A pied flycatcher was hence hatched and raised by collared flycatchers and a collared flycatcher was hatched and raised by pied flycatchers. "If song discrimination depends on early acoustic experience, we predict that nestlings should express stronger responses to playbacks of their social parents' songs regardless of species identity," the paper says.

The other trial was with cross-bred or hybrid flycatchers. Birds in aviaries were mated and there was a set of young ones, male and female, with a pied father and collared mother or a collared father and a pied mother. Trials with the song discrimination preferences could then assess the effect of maternal genes and sex-linked inheritance. "Taken together, these two approaches allowed us to disentangle the effects of experience from social parents, maternal effects from the maternal species and genetic background from both parental species," the paper says.

A powerful indicator of recognition of the parent is the start of begging calls, or cries for food, on the part of young birds. The trials showed that nestlings raised by parents of the same species responded with more begging calls on hearing parents' songs. These nestlings were also more likely to respond with "looking up" and "shifting position", which were other responses when they heard same species songs.

The other significant finding was that even nestlings raised, since the embryonic state, by parents of another species, still showed preference for calls of their real species. This finding is a strong indicator that song discrimination is not experience dependent. Another surprising finding was that this class of nestlings showed stronger response to same species songs than nestling that had been raised by parents of the same species!

The next question to test was whether it was the species of the mother that had the strongest effect on the songs to which the young would respond most strongly. If this were so, both pure-bred but foster-raised nestlings as well as hybrid nestlings should respond to songs of the biological mother's species in the same way as purebred birds raised by parents of the same species. The results, however, pointed another way — hybrid nestlings responded more strongly to pied flycatcher calls irrespective of the species of the biological mother. There was even evidence that hybrids with collared mothers responded more strongly to pied flycatcher songs than hybrids with pied mothers!

The evidence hence rules out experience or maternal effects as main factors that influence the response of young birds to songs of either species. The implication is that it is genetics that has the strongest effect. A genetic predisposition to prefer same species songs is thus the built-in safeguard to maintain species-specific mating calls and reduce instances or the effects of learning songs of related species.

Why it happens, in a few cases, nevertheless, and more males learn other-species songs, would be related to male-male competition and control of territory. The main factor that "tunes avian auditory systems to be most sensitive to conspecific vocalisations," however, would appear to lie in the genetic, and hence species-specific heritage, the paper says.

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Pied Flycatcher

Collared Flycatcher

Here comes the sun

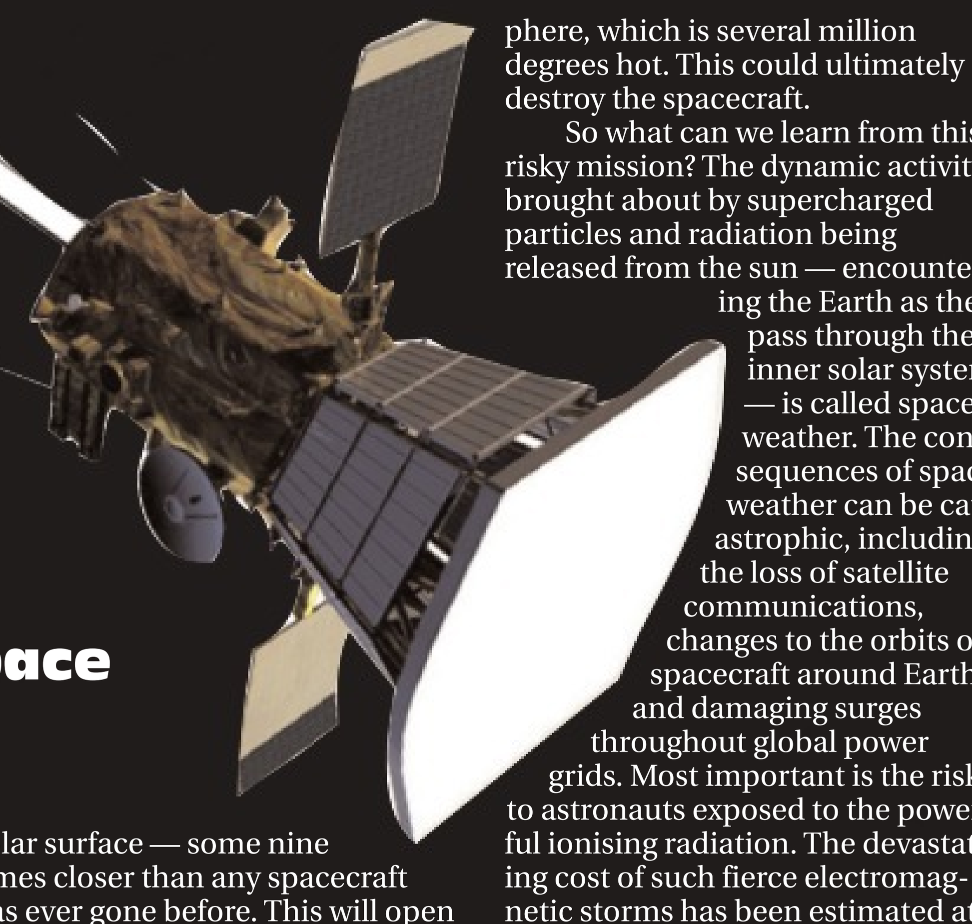
Launched by Nasa and set for lift-off next year, the closest ever solar probe will literally touch our parent star and send back vital information to protect us from space weather

DAVID JESS

From prayer and sacrifice to sunbathing, humans have worshipped the sun since time immemorial. And it's no wonder. At around 150m km away, it is close enough to provide the light, heat and energy to sustain the entire human race. But despite the fact that our parent star has been studied extensively with modern telescopes — both from home and in space — there's a lot we don't know about it.

This is why Nasa has recently announced plans to launch a revolutionary probe, set to lift-off next year, that will literally touch it. Initially dubbed the Solar Probe Plus mission, the spacecraft has now been renamed the Parker Solar Probe. This is to honour physicist Eugene Parker who carried out important work on the solar wind — a stream of charged particles from the sun.

In the past, there have been many missions to investigate the sun. In 1976, the Helios 2 spacecraft came as close as 43 million kilometres from the sun's atmosphere. But the $1.5 billion Parker probe will travel to just six m km above the solar surface — some nine times closer than any spacecraft has ever gone before. This will open a new era of understanding as, for the first time, sensors will be able to detect and analyse phenomena as they occur in the sun.



While the cruising altitude of the mission may sound like a safe distance at millions of kilometres, the sun's immense energy will relentlessly bombard the payload with heat. An 11.5cm thick carbon composite shroud, similar to what modern Formula 1 race cars employ in their high-performance braking systems, will shield the sensitive equipment. This will be crucial as temperatures will soar beyond 1,400°C.

At these extreme temperatures, the solar arrays that power the spacecraft will retract. This manoeuvre will allow the instruments and power sources to remain close to room temperature in the shadow of the carbon composite shield. Just as well, as the spacecraft will experience radiation 475 times more intense than Earth orbit. Any errors in the planned spacecraft trajectories could result in the probe sinking deeper into the sun's atmosphere, which is several million degrees hot. This could ultimately destroy the spacecraft.

So what can we learn from this risky mission? The dynamic activity brought about by supercharged particles and radiation being released from the sun — encountering the Earth as they pass through the inner solar system — is called space weather. The consequences of space weather can be catastrophic, including the loss of satellite communications, changes to the orbits of spacecraft around Earth and damaging surges throughout global power grids. Most important is the risk to astronauts exposed to the powerful ionising radiation. The devastating cost of such fierce electromagnetic storms has been estimated at $2 trillion, resulting in space weather being formally listed in the UK's National Risk Registry.

The new solar probe will revolutionise our understanding of what conditions are necessary in the sun's atmosphere to generate severe bouts of space weather by making direct measurements of the magnetic fields, plasma densities and atmosphere temperatures for the first time. In a similar way to how an elastic band can snap following excessive stretching, it is believed that the continual twisting and churning of the magnetic field lines that permeate the solar atmosphere may give rise to particle acceleration and radiation bombardment. Once the magnetic fields break, we can experience severe space weather.

Unfortunately, we presently have no direct method of sampling the sun's magnetic fields. Scientists are attempting to uncover new techniques that will allow the twists, strengths and directions of the sun's powerful fields to be determined, but so far they can't provide an accurate enough understanding. This is where the Parker probe will provide a new age of understanding, since it will be able to sample the sun's powerful magnetic fields while there.

Round-the-clock observations and direct measurements of the atmospheric conditions responsible for increased levels of space weather are paramount in order to provide crucial warning of imminent solar threats. An instrument suite on-board the probe, the Fields suite, will provide such unprecedented information. Scientists can then feed this into intensive computer models, ultimately allowing space, aviation, power and telecommunication authorities to be alerted when potentially devastating space weather is imminent.

Of course, understanding the origins of space weather also has implications for other important areas of astrophysical research. It will allow space agencies to better protect astronauts during future manned missions to Mars, where the thinner Martian atmosphere offers little protection to incoming solar radiation.

Also, by being able to accurately model the effects of the streaming solar wind, future spacecraft will be able to effectively use solar sails to help them reach further into the depths of the solar system, perhaps eventually opening up the possibility of true interstellar travel.

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The independent

PLUS POINTS

Go out of the box

Passing an electric current through the brain can help people be more creative, according to new research.

Scientists found that suppressing an area of the brain involved in thinking and reasoning helped people to "think outside the box" when trying to solve complicated problems. While the research suggests people could one day wear an electrically charged hat to make them smarter, scientists stressed this was not possible at the moment and cautioned against claims by companies selling such devices.

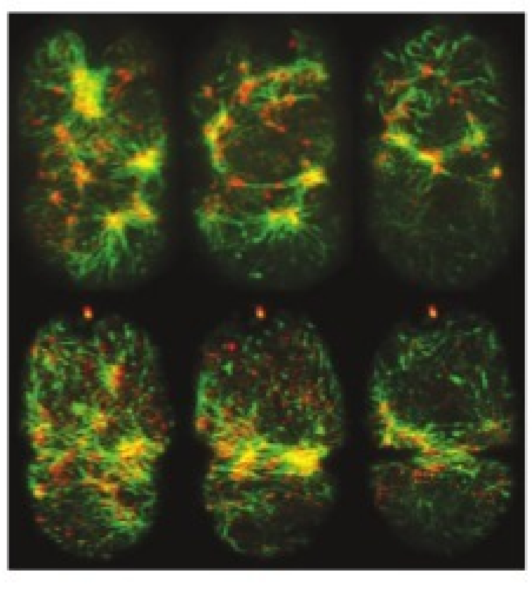
In the study, 60 people, all right-handed and aged between 18 and 34 years, were asked to solve "matchstick problems" after having electricity passed through the brain area in one direction, which stimulated it, or the opposite direction, which suppressed it, or without having any electricity at all. The electric current was weak enough not to cause any unpleasant feeling, but it did have an effect the participants' minds.

While stimulating part of the brain involved in reasoning might be expected to boost performance, it actually had no effect on the performance in the test. But suppressing the area, called the left dorso-lateral prefrontal cortex or DLPFC, resulted in a significant improvement because it helped the participants think in a different way to normal. One of the researchers, Caroline Di Bernardi Luft of Queen Mary, University of London, said, "We solve problems by applying rules we learn from experience, and the DLPFC plays a key role in automating this process. It works fine most of the time, but fails spectacularly when we encounter new problems, which require a new style of thinking — our past experience can indeed block our creativity. To break this mental fixation, we need to loosen up our learned rules."

A paper about the study in the journal *Scientific Reports* said the DLPFC role in applying previously learned rules was usually an efficient way of solving problems. "But our results also suggest that potential applications of this technique will have to consider the target cognitive effects in more detail," Di Bernardi Luft said, "I would say that we are not yet in a position to wear an electrical hat and start stimulating our brain hoping for a blanket cognitive gain."

Ian Johnston/the independent

Cell division



A single fertilised cell of a C elegans worm seen here in six stages of its first division. Here, the parent cell is dividing into two daughter cells in the earliest stages of embryo development. The study by a team of researchers from the Mechanobiology Institute at the National University of Singapore, led by assistant professor Ronen Zaidel-Bar, looked into how proteins work together in a living organism to produce higher-order structures and transmit mechanical force during crucial developmental processes such as cell division and polarisation (a process where cells undergo shape changes to become asymmetric).

Changes in cell shape, and the pinching of the cell that leads to cell division, are dependent on the formation and function of higher-order structures that can generate pulling or contractile forces. These structures are composed of actin filaments and myosin motor proteins (red) together with proteins that can bundle actin filaments together. In this study, the MBI researchers discovered that plastin, an actin-bundling protein (green), acts as a molecular rivet to strengthen the contractile network and facilitate cell division and polarisation in the C elegans embryo.

The straits times/ann