Quick guide

Corvid cognition

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What is a corvid? There are just over 120 species of corvids, a family of songbirds that includes the crows, ravens, rooks and jackdaws, as well as the more colourful jays, magpies and nutcrackers. Although belonging to the same order as nightingales and other birds with melodious songs (Oscines), corvids tend to be identified by their raucous calls. Little is known about corvid songs, perhaps because they are surprisingly quiet. Corvids can be found throughout the globe, except for the southern most tip of South America and the polar ice caps. In Britain, many of the common species, such as magpies and crows, steal other birds' eggs and raid agricultural crops. They are therefore treated with disdain by many birdwatchers and farmers.

Why study intelligence in crows? Corvids have not always had such a bad press. Native Americans believed that a raven had created the earth; the Norse god, Odin, consulted two ravens Hugin (Thought) and Munin (Memory) for their wisdom; and Aesop cast corvids as the smart protagonists in many of his fables. Along with their reputation in folklore as the wisest of animals, corvids have the largest brains for their body size of any bird. Perhaps most surprisingly, the crow brain is the same relative size as the chimpanzee brain. Other aspects of corvid biology also give us clues to their intelligence. In the wild, young corvids have an extensive developmental period before they become independent from their parents. This allows them more opportunities to learn the essential skills for later life. Many corvids also live in complex social groups. For example, in the cooperatively breeding Florida scrub-jay, several closely related family members share the responsibility of raising the young with the parents. Furthermore, rooks congregate in large colonies, where juveniles associate with many non-relatives as well as kin. In both cases, this long developmental period provides increased opportunities for learning from many different group members.

Perhaps it is not surprising then that many corvids are also renowned for their innovative feeding skills. For example, Japanese crows in Sendai City have learned to crack nuts safely by dropping them onto pedestrian crossings and waiting until the traffic lights turn red before retrieving the nut's contents. Rooks at a motorway service station in England have discovered a novel method for gaining access to food thrown in rubbish bins. Two birds cooperate in pulling up the bin liner and then either feeding from the raised food or tossing the contents onto the ground where the waiting crowd of colony mates reap the rewards.

As the crow flies... Most of the corvids that have been studied in detail hide food for the future in times of food abundance and then rely on memory to recover the food caches at a later date when food is scarce. For example, the Clark's nutcracker is estimated to hide over 30,000 pinyon seeds in many different places during the autumn in preparation for the harsh months ahead. Laboratory experiments have shown that they have highly accurate spatial memories, which enable them to recover these caches up to 9 months later. This is no mean feat when there are so many caches to keep track of, scattered throughout the territory, and when many aspects of the landscape change so dramatically across seasons. It has been suggested that Clark's nutcrackers rely on remembering the location of large vertical landmarks such as trees and rocks in the environment, because these landmarks are unlikely to be blown away or buried under the snow.

What do scrub-jays recall about past caching events? Although western scrub-jays do not hide as many seed caches as the nutcrackers, they are known to cache a variety of perishable foods, such as insects and fruit, as well as non-perishable nuts and seeds. In the laboratory, these birds demonstrate remarkable memories for what they have cached on a given day, and how long ago, as well as where they hid the various food items during that particular caching episode. This ability to remember the 'what, where and when' of specific past events is thought to be akin to human episodic memory, because it involves recalling a particular episode that has happened in the past. Until recently, this ability was thought to be unique to humans.

Avian espionage... Food-caching is a risky strategy, however, because the caches can be stolen by other birds. In addition to hiding their own food caches, corvids also play the role of thief: they watch and remember where other birds have hidden their caches and use this information to steal those caches when the owner has left the scene. When playing the role of thief, speed is of the essence and may make the difference between a successful raid and vicious attack by the owner of the food-cache. Not surprisingly, corvids also employ a number of counter strategies to reduce the risk that their own caches will be stolen by another bird. For example, they attempt to cache out of sight from potential thieves, or wait until the raider is distracted before hiding their caches, and if that is not possible, they hide caches in places that are difficult for the thief to see. When there is little option but to cache when others are around, then the birds will return to the caches once the others have left, and quickly re-hide any remaining caches in new places unbeknown to the potential raider.

Laboratory experiments have established that western scrub-jays use all these techniques to protect their caches from potential thieves, and only do so if another bird is present at the time of caching. Furthermore, they only move their caches to new hiding places if they have been thieves themselves in the past. Naïve jays, even ones who have watched other birds caching but have never had the opportunity to raid those caches, do not do so. This suggests that experienced birds relate information about their previous experience of being a thief to the possibility of future theft by another bird, and adjust their caching behaviour accordingly. Using your own experience to predict another individual's future behaviour in relation to your own — 'putting yourself in someone else's shoes' — is thought to be one of the hallmarks of Theory of Mind, another ability that was thought to be uniquely human.

Cultural tool use in crows? New Caledonian crows are extraordinarily skilled at making and using tools. In the wild, they make two types of tool. The hooked tools consist of twigs that are trimmed and sculpted into a functional hook, which the crows use to poke insect larvae out of tree holes. The crows also manufacture stepped-cut *Pandanus* leaves, which they use in different ways for different jobs: they make rapid back and forth movements for prey under soil, yet slow deliberate movements if the prey is in a hole. These tools are consistently made to a standardized pattern and carried around on foraging expeditions. The only other animals that display this diversity and flexibility in tool use and manufacture are the great apes. Thus, chimpanzees have been observed to manufacture a range of different tools that are used for specific purposes, and different geographical populations of chimpanzees use different tools for different uses, suggesting that there may be cultural variations in tool use. Observations of the crows' tool use in the wild also suggest similar levels of cultural complexity. For example, there is potential cumulative evolution in the complexity of stepped tools (increasing the number of steps required to make a more complex tool), analogous to minor technological innovations in humans. Crows from different geographical areas have different designs of tool, suggesting that crows may also show cultural variations in tool use.

Figure 1. A huddle of ravens (photograph courtesy of Nathan Emery).

Laboratory experiments confirm the sophisticated intellectual capabilities of these crows. One tool-using crow, called Betty, can manipulate novel man-made objects to solve a problem, such as reaching food in a bucket only accessible by using a hook to pull the bucket up. When the bent wire was stolen by another bird, Betty found a piece of straight wire that was lying on the floor, bent this wire into a hook and used it to lift up the bucket and reach the food! Betty proceeded to do this consistently. Furthermore, when given a tool box containing a variety of different tools to reach normally inaccessible food, she was able to select one of the correct length and width. So evidence of tool use and manufacture suggests that these crows can sometimes combine past experiences to produce novel solutions to problems.

Feathered apes? Corvids are large-brained, social birds. They have an extensive developmental period in which they are dependent on their parents, and so have a long time-window in which to learn many different things from their parents and peers. They show a great propensity to find innovative solutions to novel problems, from the manufacture of tools to the protection of food from competitors. Furthermore, they appear to be particularly adept at predicting the future behaviour of conspecifics. These features are things they share in common with the apes. The common ancestor of mammals and birds lived over 280 million years ago, so it is hardly surprising that they have very different brains. It follows that intelligence in corvids and apes must have arisen independently in two groups with very different brains. Interestingly, the thinking part of the brain is correlated with propensity to innovate in both birds and primates, with the corvids and apes as the 'star inventors'. So when it comes to intelligence, corvids are feathered apes.

Where can I find out more?

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