Teamwork Builds Big Brains

The average adult human's brain weighs about 1.3 kilograms, has 100 billion or so neurons, and sucks up 20% of the oxygen we breathe. It's much bigger than an animal our size needs. According to a new computer model, the brains of humans and related primates are so large because we evolved to be social creatures. If we didn't play well with others, our brains would be puny.

The idea behind the so-called social intelligence hypothesis is that we need pretty complex computers in our skulls to keep track of all the complex relationships we have with each other – who's a friend, who's an enemy, who's higher in the social ranks. Some studies have supported this idea, showing for example that bigger-brained primates tend to live in bigger social groups. The same appears to hold true for dolphins. But these studies only identified associations between brain and group size; they don't show how evolution might have worked.

Since they didn't have a few million years of time on their hands, Ph.D. student Luke McNally and colleagues at Trinity College Dublin simulated evolution on a computer. They started with 50 simple brains. Each had just three to six neurons. The researchers then made each brain challenge the others to one of two classic games: the prisoner's dilemma or the snowdrift game.

In the prisoner's dilemma, two people have been taken in for questioning by the police. If both keep their mouths shut, they'll both be set free. If one sells out the other, the snitch will get off and the other will do a long stint in jail. If they tell on each other, both get shorter sentences. If the game lasts only one round, it's better to turn in your accomplice. But over the long term, players can start remembering who's done them a favor and learning to cooperate by maintaining their silence. In the snowdrift game, two people need to dig themselves out of a snowdrift. The best outcome for each player is to sit back while the other one digs, but digging cooperatively isn't bad, either. In each game, a player's only choice is whether to cooperate.

After playing one of the games, the brains reproduced asexually. Individuals that did better were programmed to be more likely to have offspring. Then all of the brains in the new generation had a chance to undergo a random mutation. The mutations could change the brain's structure, number of neurons, or the strengths of the connections between those neurons. Each simulation ran for 50,000 generations, with 10 runs of the simulation for each of the two games.

As time went on, the researchers measured how much the brains cooperated with each other and how many neurons the brains had – an indicator of how intelligent they were. "As you transition towards a more cooperative society, that's where you get the maximum selection for big brains," McNally says. Bigger brains did better as cooperation increased. That meant they got to reproduce more, which meant more brains had the capacity to cooperate with others. "It's a simultaneous process – as cooperation is increasing, there is more selection for intelligence," McNally says. Obviously, these tiny brainlike computer entities aren't doing anything remotely as complicated as what a primate brain does. But since the only choice was whether to cooperate, the results suggest that the mere existence of cooperation is enough to make brains evolve to be more complex, the team reports online today in the *Proceedings of the Royal Society B.*

The simulation is a long way from real life – but that's OK, says cognitive biologist Richard Byrne of the University of St. Andrews in the United Kingdom, who did not work on the study. "Some people would argue that the prisoner's dilemma and the snowdrift problem might not be like the real social challenges that a primate or a dolphin confronts, but maybe they're the best we've got," Byrne says. "I personally wouldn't quibble." He describes himself as "keen on the social intelligence idea" and likes the paper, but points out that this hypothesis doesn't explain all animal brainpower. New Caledonian crows, for example, are impressive thinkers, but they aren't social. He thinks that those birds have evolved intelligence to deal with certain hard-to-get foods. That need may also have contributed to the evolution of intelligence in apes, he says.

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