Interview with Sarah Brosnan: The evolution of cooperation

Cooperation in the natural world.
So, cooperation has been a bit of a conundrum for decades. It was something that Charles Darwin had problems with in fact because if it is as we say, 'nature red in tooth and claw', and it is individual selection, why would individuals ever work together?

And from an ultimate perspective, which means looking at it from an evolutionary perspective or why the behavior should evolve, it makes sense and that sometimes organisms actually can do better if they work together. So, they can, by working together, they can achieve things that they wouldn't otherwise be able to do and on the long run this is beneficial.

So, if you look at it that way then you should see cooperation evolving and there are a number of proposed mechanisms through reciprocity, through kin selection, through mutualism, where both individuals benefit. One of the things that I'm actually interested in studying is how unequal outcomes influence the willingness to cooperate, because if it's evolving because both individuals do better than they could working on their own, but one individual does more better than the other —if you'll pardon that bad grammar— then that should select against cooperation because natural selection is relative. So if you and I are working together and we're both absolutely better off, but the fact that we work together makes you relatively better off than I am then it's not in my best interest to have cooperated. So, one of my long-term research interests is looking at how unequal outcomes influence it and how the animals work around this and it turns out they can, but it's an important question.

How do you study cooperation, what are the main questions?
I am interested in studying the non-human primates because it gives us a window into our evolutionary history. So, humans and chimpanzees separated on the evolutionary tree about five to seven million years ago and other species it's longer ago. That doesn't mean that a human evolved from a chimpanzee, it means that a human and a chimpanzee evolved from a common ancestor that was something different from either of us, but we can't go back and ask the ancestor from 10 million years ago what they did or study them, but what we can do is we can look across the primate species and try to triangulate in on what might have been what some of the shared characteristics of this common ancestor.

I also like to always mention that I happen to study non-human primates and we are primates, but that doesn't mean that you can't learn about humans from studying other species. So it's natural to look at the primates first because they look so much like us and they act so much like us, but especially when you're thinking about convergent evolution, which is this idea that similar selective pressures lead to similar behaviors, you actually need to look broader than more broadly than the primates.

In my area one of the big questions has been how come you've got these certain species within this, these different taxa that show high levels of cooperation and seem to understand it —so for instance you have the corvids among the birds, you have the dolphins among the cetaceans, you have the dogs and the wolves among the canids, you have humans and chimpanzees and capuchins and several other primate species among the primates. Part of the reason why we're seeing more in some species than others is undoubtedly research effort —we haven't studied every species out there equally and some taxa have been nearly ignored. So we really don't know what's going on in there, but by looking across these different species that share things in common like atypically large brain-to-body ratios or the fact that they live in large groups with non-kin we can start to see where the similarities and differences are. And both of course are important as you alluded to.

We want to see how humans are similar to other species to see what the, what the features we shared in common were, but we're also interested in how we're different —so what is it that makes humans distinct? That's one reason why for most of my research we include humans, humans are almost the out group for us. But we take all of these paradigms that are used typically to study behavior and cognition, we adapt them to look at non-human primates and other species, but they've been adapted. So we need to sort of back test them on humans to see how humans respond to our adapted paradigms so we can make a fair comparison.

Language and other unique human features in cooperative behavior

Language allows humans to communicate outside of the immediate. So we can talk about the past, we can talk about the future, we can make plans. It allows for third party interactions that aren't possible with other species so I can come up and tell you that somebody did something horrible to me. Chimpanzees can't do that. They do have third party interventions, but it has to be witnessed because they don't, they have sophisticated communication, but they don't have the language to be able to talk about something that happened in the past in the same sort of way. Now the interesting thing is we've looked at language with our economic games and language certainly makes a difference. Humans are using language to take very difficult to solve simultaneous games and turn them into what are essentially sequential games, where one they can say hey you try this and I'll try this and let's see what happens. But humans are still able to solve a lot of these games even without language when we put them in situations where they can't use it. So language is important, but I think there are other things that are important too, we have better planning abilities and so forth, and how it's all tangled up with language, you know, it clearly is and we don't necessarily know how.

There's this sort of big ideological divide about whether humans are very distinct compared to other species or there is a continuum. It's clearly both. We're both part of a continuum and we're distinct and where you see humans lying... there are different ways to interpret the data reasonably. Language is clearly important. Planning is clearly important. The ability to use these things to do large-scale cooperation in a way that isn't typically seen in the animal kingdom is clearly important. Which none of these appear to be uniquely human. They appear to be better developed in humans and used in different ways in humans, but not necessarily uniquely human. And that's the challenge is figuring out how we sort of put together the building blocks to make something that's so fundamentally different in so many ways.

In primates, where is cooperation 'encoded'?

Yeah, I don't have a great answer to that question right now so I'll back up a little bit. Cooperation is widespread throughout the animal kingdom, so it's one of the reasons it's such a conundrum is because it's everywhere. It's not like a few higher level organisms have figured out how to do it.

One of the things I routinely point out when I start my talks is that you can study cooperation in single-celled organisms and bacteria and ants and bees and some of these species, in many respects,

are better cooperators than we are. What I have really gotten interested in is the flexible cooperation where individuals, in principle at least, can decide on any given interaction whether or not they're going to cooperate.

So, if I'm a bacteria and my genome is producing an enzyme that assists other individuals, it still functions cooperatively, but the bacteria isn't deciding most of the time, although there's more evidence that they might be using it contingently, but the bacteria isn't necessarily deciding what's going on. With the primates there's probably a little bit of both. I mean one of the things that people have gotten really interested in is trying to figure out how cooperation comes into being. There's no gene for cooperation in primates the same way there is in bacteria, but there are genes for oxytocin receptor distribution and genes for how, you know, how your neurons are spread out and what connects to what. There are genes that make some individuals more social than others and so these for through a variety of mechanisms and so these are clearly contributing.

There's also their experience and there's also probably their culture, and we have good evidence that there are individual differences that aren't easily explained by things like, "oh that's the dominant versus the subordinate" or, "it's a male versus a female or age", so the sort of standard demographic thing. I can't tell you what it is besides just saying that they're individual differences and they tend to, they tend to map onto other individual differences. For instance, individuals who respond to inequity are much more likely to be the more social individuals. They're more engaged with the group. How much of that is genetic and how much of it is cultural or developmental we don't know. I mean there's really good evidence that a lot of these species are passing on quite a bit of information either horizontally or vertically through cultural transfer.

We've got information across a wide variety of species of cultural differences or traditions, they're called different things in behavior, that aren't easily explained by differences in ecology —so chimpanzees that crack nuts in different ways or that use tools and other tools in different ways. You see that in birds, you see it in primates, you see... I'm going to miss some. You see it in a lot of species and so it's clearly widespread as well. We also know that there are some behaviors and traits that they don't learn well if they don't have a proper model. So in a lot of species, not just the primates, it's not enough just to be born. Your development requires this input from other members of your social group, just like it does with humans.

What are some of the reoccurring themes in your research?
Overall, one of the things that always gets driven home to me is, in many respects, how similar we are to other species. So, watching I think one of the reasons people love going to the zoo and watching animals is because they remind us of ourselves. They do the same sorts of things especially when you see a primate where it's easy to identify because our body maps onto their body. That's probably easier than a quadruped or something like that. You see them playing, you see them interacting with each other, you see them looking like they're having fun. So it drives, working with them day in and day out, drives home the similarities, how much we are like them.

My, research wise, we've shown that cooperation is actually really widespread and we've recently focused on using economic games, so like the prisoner's dilemma or the assurance game. So these are games where you simplify, it's almost like a model system, where you simplify down complex decisions and very simple decisions —usually dichotomous choices. Do you cooperate or do you defect. And the whole point is that you can apply these in a variety of context, or in my case a variety of species, and have a very structured environment so you can find similarities and differences. And what we find is that the primates actually do really well on cooperation, but they're not all using the same mechanisms.

So, some of them are solving the tasks and cooperating in different ways. For instance, capuchins tend to just match what their partner does, which makes sense if you're a capuchin. They live in fairly small groups, they're typically not out of view of one another so they should be able to see what their partners are doing most of the time. Chimpanzees and Rhesus monkeys that live in larger groups, or in the case of chimpanzees fission-fusion groups where only subgroups are usually together, you see more complex mechanisms for solving these cooperative tasks. So we're finding that even though everyone can get to the same outcome, most of the time, they're often doing it in different ways that we think are reflective of their ecological and evolutionary history.

Have you observed cheating in your experiments with non-human primates?
We haven't seen a whole lot of cheating, partly because our experiments have been set up where it would be difficult to do. That's something we're actually hoping to get into. Right now what we're trying to do is to look at cooperation where we have individuals cooperating to compete with another group. And I expect you'll see more cheating there. The closest we've come to cheating is looking at how individuals respond when they have to work together to get an outcome and the outcome is not always the same.

So we did a task where subjects worked as pairs, and these are subjects from the same social group so they grew up with each other and they know each other really well they have strong established relationships, and so we had them work together to pull in a tray that had food on it, and they are really really good at that, but we started adjusting the foods so that one would pull in for a lower value food than the other. We didn't separate the monkeys so they got to choose who was going to pull in where and what we found was some of the pairs worked it out fairly nicely. Where when the foods were uneven and equal, each one got the better food sometimes and in some pairs the dominant kept taking the better food and when the, which is cheating, and when the dominant would take the better food the subordinate would quit participating. So you ended up the dominants who were fair and shared more, whatever fair means to a monkey, and were more tolerant of their partners and let them have the better reward sometimes ended up getting more overall rewards than the dominants who always tried to take the better reward. Which, I mean, there are certainly life lessons there.

What about punishment?
Punishment is remarkably rare in the animal kingdom and nobody's quite sure why. There is good evidence of punishment actually in cleaner fish. From a theoretical perspective one of the arguments is that there are two ways to change another organism's behavior and you can either exhibit partner choice, where you just say I'm not working with you anymore and go off and find someone new to work with, or you can do partner control, which is when you punish and try to get the partner to do what you want.

Most of us intuitively think that there's some punishment going on, at least mild punishment in the sense of partner control. We ran a study where one subject could choose which of two distributions of food they wanted to share between them and a partner and if they chose the one that was unequal we got a lot of banging and screaming and things like that —that could be punishment— but it didn't happen very often. So it's been extremely difficult to test in the lab because typically one or two of those instances changes the behavior of the individual who was supposed to be cooperating so you don't get enough data to run inferential statistics on. It becomes an anecdote. So there probably is some, but they also exhibit a lot of partner choice mechanisms. So for instance if they're working with someone who keeps taking advantage of them they just quit working with them all together. So that's not punishment in the biological sense of paying a cost to change another organism's behavior. It seems to be much more a partner choice mechanism of, "I'm just not going to work with you at all anymore".

Collective behavior: always for good?
We often do very, very, well and we often do very, very, poorly it's the old idea of the tragedy of the commons that Lin Ostrom was the one who really pioneered. And if you can set parameters in place so that everyone benefits and that it makes it very much more difficult to cheat, collective goods are often shared very well, but once you start trying to legalize it it often falls apart. So a lot of her research was looking at water rights and other resource division where tribal custom often did a better job than when you come in and try to impose rules from on top. So one of the reasons to study this is to try and figure out how you can get these organisms to work together better and working in humans can be tricky because humans have all this culture layered on top and we can't do some experiments with them because they're not going to come spend four hours in the lab. But we can study it in primates where we do know their relationships, we know if they're being tested with someone they get along with or someone they don't get along with in their normal day-to-day lives. They have long-term relationships and we can see how their willingness to share, and so forth, have developed.

In general, how do you approach a scientific problem?
With the research that I do, the best questions are often derived from what you see the animals doing anyway. So I encourage my students to spend a lot of time outside watching —What do you see? What does it look like you see? I mean it's kind of anthropomorphic in many respects because we're applying what we think is out there to these organisms. Do you think you see punishment? I actually have a student studying punishment. Do you think you see punishment? Do you think you see responses to inequity? If you do try and figure out the context in which you saw it and then we design a study to look for it. So we spend a lot of time out trying to derive what are the interesting questions from watching the other species. You can do a top-down approach too, which is, "we've got this huge question in about humans let's try and design something to study it in other species", and that works as well. But some of our most interesting research has been this much more bottoms up approach, where you look at what the animals are actually doing and try to derive it from that. And I think you can do that across the animal kingdom.

Coda.
With these guys what we do is we just give them access to the paint and let them do whatever they want with it, and they enjoy it. What's interesting is they will be very clear when they're done. So that one up there that you're taking a photograph of was actually done by a chimp named 'Joey', and what I remember specifically is he got to the end and he put that purple splotch in the lower left hand corner and then he was done. And when they're done, they just pass the canvas back to you.

So how would we know if another animal was conscious? I mean, we even argue about whether or not they have theory of mind, which is the ability to recognize that other individuals think about things differently than you do. There's certainly some evidence that they at least have perspective taking, but to what degree is theory of mind we don't know.

The art —they also seem to like music and they have strong musical preferences and there is some evidence of things like rhythmic drumming and so forth, which implies that maybe there's more there than just, that maybe there is something aesthetic there.

Sarah: Just let me put some tea in here.
Camera: That's a really nice tea pot!
Sarah: I love my teapot! My teapot has monkeys on it, it's from the Japanese Year of the Monkey.

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