Dorcas Cummings Lecture

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Dr. Patricia Churchland presented the Dorcas Cummings lecture entitled “The Brains Behind Morality” to friends and neighbors of Cold Spring Harbor Laboratory and Symposium participants on Saturday, May 31, 2014. Dr. Churchland is Professor Emerita of Philosophy at the University of California, San Diego, and an adjunct Professor at the Salk Institute.

It’s a great, great pleasure to be at Cold Spring Harbor Laboratory and a special honor to be speaking to the wider community of Cold Spring Harbor.

Today, I want to talk a little bit about morality. I’m going to begin with thinking in the normal way that we do about natural selection. What we know, of course, is that animals who are well-adapted to the particular environment they live in, if they can compete and prosper in that environment, are more likely to pass on their genes. Those who do not do so well will not pass on their genes.

We all understand in a very straightforward way the kind of competition that exists both within a species and across species in order to survive and reproduce. All animals have the neural wherewithal for organizing themselves to feed, to flee in the face of danger, to fight if they have to, and to reproduce. In neuroscience, these have been called the 4 Fs—feeding, fleeing, fighting, and reproduction.

If you look at it this way, then there’s a certain sense in which value is right in the very basic structure of the organism, but it is a value that is very egocentric. It is very selfish. This has prompted some evolutionary biologists—for example, Richard Dawkins and Ed Wilson—to say that we are not just with respect to our genes selfish, but with respect to our social temperaments, we are fundamentally selfish. Consequently, morality or the capacity to incur a cost to benefit others has to somehow be imposed from without. It has to be shoved on us or scared into us.

Interestingly, I think, Darwin had a very different view. Darwin took the view that there are many species of social animal and that in the human case, our sense of morality or our conscious depends on essentially three things: our social instincts (our fundamental biology), habits and skills that we acquire in our lifetime, and reason, or as we might say, the capacity to problem solve.

Of course, Darwin didn’t have the advantage that we now do of knowing something about the brain. Almost nothing was known at that time. What is new, I think, in the field of social neuroscience is that we’re beginning to understand the biological basis for sociality, and that

gives us really striking and interesting clues about the biological platform on which the superstructure of laws and norms and so forth can be built.

In thinking about this, it’s useful to take advantage of what the bones and stones people, the anthropologists, have told us is the best hypothesis about early humans. As you know, there have been many species of humans. *Homo sapiens* has been on the planet only about 200,000 or 250,000 years. For most of that time, we lived in very small groups. We hunted, we gathered. There was probably some interaction for trade, mainly trade of females, but it wasn’t until about 10,000 years ago with the advent of agriculture that we began to see large communities develop. It was really only very recently that we see anything like an established or a systematic religion.

Whatever norms and social rules and practices these people had, they grew up within the context of these very small groups where everybody knew everybody else. From the data on hunter–gatherer groups existing in the last 150 years, it would appear that they had social practices regarding the really essential things—how to resolve conflicts, what to do in times of dire straits when the resources were very low, what to do with orphans, and basically how to share food. That is not terribly complex, but those are the basic and fundamental moral issues that would have arisen in this context.

We think that social species evolved many times but under rather different organizing principles. There are, of course, social fish like the discus fish. There are many species of social insects, but sociality in mammals is very different. It has a kind of flexibility. It has, as we think of it in our own case, a kind of emotional component that is probably not there in insects and fish. This is likely also true of birds, perhaps by separate evolution, perhaps by common ancestor.

Now, you might be thinking, “What exactly do you mean by morality?” and, “What do we mean by honesty, or by friendliness?” or whatever. I’m going to draw on some very old—that is, 1960s—work by Eleanor Rosch, which I think is terribly important in orienting us in the right kind of way to these subconcepts. Her basic finding

is quite simple, which is that our workaday concepts, our everyday concepts, by and large have a radial structure. What she meant by that was that there are prototypes at the center, and then there are fuzzy boundaries, and then in between, there's everything else.

The standard case to think of here is the concept of vegetable. It turns out that if you ask people, "What's the first vegetable that comes to your mind?" most people say "carrot", and almost everybody thinks carrot is a vegetable. On the other hand, part way out in the radial structure are radishes. Some people think, "They're just garnishes. Who would eat such a thing?" Way, way out on the fuzzy boundary, are things like, say, wild mushrooms. You might find them in the supermarket with the other vegetables. Does that really make them a vegetable?

The important understanding that Rosch had here is that for most purposes, it really doesn't matter that we have necessary and sufficient conditions for defining vegetable. I do not care whether parsley really is a vegetable. For most of our communicative purposes, we don't care. In science, we often do care, and we do want precise definitions.

I'm bringing this up because, of course, I think moral concepts are like this, too. They're like this in a way in which the concept of a dwelling or a house is like this. That is, that there are prototypes relative to a culture. What the Inuit regard as a prototypical house is different from what you would regard in this community as a prototypical house, or the house I grew up in. It's culturally relative, although there is, as Wittgenstein would have said, a kind of family resemblance running through them.

Now, this is interesting in the present context because I want to say that social categories are like that, including the category of moral and its correlative, not moral. What it is to be a friend, to be honest, to be kind, to be brave, to be trustworthy—these are all radial concepts. Sometimes, we disagree about the boundary cases; often, we perfectly well agree on the prototypical cases.

I think the same is basically true of what we count as moral, especially within a culture, but of course, we are going to see cultural differences. Across cultures, it tends to be the case that we find a lot of agreement on the prototypes. Most people think that it's deeply immoral to neglect or beat or abuse children, but then you get out into the boundaries, and there are other things that may be considered moral or may not. Sometimes, they matter, and sometimes less so. That's the background point I want to make about the category of moral and immoral. You might wonder whether there is a possibility of making it more precise, as we might make the notion of a protein more precise. I don't know. It kind of depends.

The hypothesis that I'm interested in here, given developments in social neuroscience, is that at least in the case of mammals, sociability turns out to be a basic value—and that's as a result of natural selection, and I'll explain why in a minute—and that the hub of the story depends on a peptide, oxytocin, a very ancient peptide, as it turns out. It has a sibling peptide, vasopressin, and they're both extremely important. When I say it's the hub, I don't mean, of course, that it's the only thing, but it plays a

very crucial role and is probably regulatory with regard to some of the other neurochemicals.

Now, norms, which many people think typify morality and ethics, almost certainly emerge as a result of interactions of the young within the social context and involve the reward system in the brain. I'll say a little bit more about that. I think of norms, those social practices which may or may not be explicit, they may just be picked up. For example, here's one that's picked up when you first meet someone, and you're having a conversation, how close is it appropriate to stand? Most of us could not actually say. We might not even know that we know that, but we do *do* it, and we notice when there is a violation of that social norm, the norm that's relative to our own group.

The question then is if mammals are somewhat special in this regard, how did that come to be? What were the evolutionary pressures that brought about mammals at all, and what is it that brought about their sociality? Now, I want to talk a little bit about food. Before there were mammals, there were lots and lots of reptiles, and reptiles, of course, are cold-blooded. At some point around 200, 250 million years ago, there appeared warm-blooded creatures, not yet mammals but warm-blooded reptiles.

This was important because it meant they could hunt at night when all the other creatures had to wait until the sun warmed them up so they could be busy. Moreover, the warm-blooded creatures could hunt those sleeping reptiles. They could also avoid predation by those who were sleeping. In addition, they could go to very new environments, where it might be cold in general, and they could count on their thermoregulation to keep them functional.

The downside of being warm-blooded is that gram for gram you have to eat 10 times as much as your cold-blooded friends. It also means that a given patch of territory might support many lizards but few rodents or foxes. So a very different ecology emerges once you've got warm-blooded animals and Mother Nature basically said, "How are we going to make this all work?" One of the things evolution chanced upon is that it is hugely advantageous if these warm-blooded creatures have the capacity to learn—not just learn a little bit but really learn a lot about the causal structure of the world. This means they will have intellectual and cognitive advantages. Additionally, the brains can tune themselves up to a variety of different environments, so when food runs out, they can go elsewhere, even to cold climates. If the brains of the very young are so plastic (able to learn so much), when they are born their brains need to be very immature. Thus, there's a trade-off between a learning capacity and immaturity at birth. And, surprisingly perhaps, this immaturity at birth turns out to be the basis for sociality.

The cortex, of course, is unique to mammals. Within it is this really amazing cellular organization, very well-defined layers with specific cell types and specific wiring in each layer. Reptiles don't have anything like it.

We do not really understand how cortex evolved. Of course, one of the great things about cortex, as we know, is that it gives us flexibility because you're born very

immature, and cortex tunes itself up to the environment, whether it's the particular physical environment—you're in the arctic or in the Brazilian jungle—or the social environment, so you come to acquire the appropriate habits.

We sing the praises of cortex but subcortical structures are absolutely crucial and a critical part of the reward system. You're not going to acquire any skills or habits—in fact, you're not going to make good use of cortex—unless those structures are in place and unless the right kinds of loops between cortex and those deeper structures are in place.

Having a big cortex means you can learn a lot of stuff, simple stuff or more complex, more abstract. And the more abstract you get, the more deeply you can penetrate the causal structure of the world, and the further into the future you can envisage to predict how things are likely to turn out.

Let's go back to newborn dependence. If the newborns are very immature, Mother Nature has a problem. With reptiles, she's got these fundamentally egocentric animals, and now she's got these babies that are born highly dependent. How is she going to arrange for them to mature? Although we do not entirely understand the evolutionary steps involved here, we do understand the outcome. Which is that over evolutionary time, there was a kind of restructuring of the hypothalamus in the brain, in tandem with the development of this amazing temporary organ, the placenta. The placenta and the hypothalamus coordinate their hormonal communication.

An important backfill here is oxytocin. Its presence in the nervous system long precedes the evolution of mammals. In pre-mammalian creatures such as frogs, it was involved in ejecting eggs from the female and sperm ejection in the male. But in mammals, it was put to new jobs. In particular, it seems to have been absolutely crucial for lactation—for milk ejection.

In all nervous systems, the hypothalamus is so critical for feeding, mating, attacking, and defending. In the mammalian brain, oxytocin is released, and the upshot is the mother strongly bonds to the offspring, who in turn strongly bond to the mother. What does bonding mean here? It means that just as the mother cares for her *own* food and warmth and safety, she cares for the food and warmth and safety of the other—the infant. It's as though the infant is an extension of her—its interests are *her* interests. This arrangement is a very interesting genetic trick that takes us from the realm of the truly egocentric to the realm of caring for another in almost the same way as you care for yourself.

While she was at it, Mother Nature rigged it so that you feel pleasure when you are with the child and you feel pain when you are separated. She gave the offspring vocalization so they would squeal when they were separated or when they were hungry. We all feel pain when the offspring squeal, and we take corrective action. During the evolution of mammalian care, there were many modifications, but the basic and very big thing involved caring for others, enjoying and wanting and liking being with them, feeling pain at separation, feeling pain at their pain, and taking corrective action.

This seems to me to be a huge change in the evolution of living things. All of a sudden, we care for these others, we are prepared to sacrifice for them. You might say, "We care for these others because they carry our genes." Fine, but parents incur a huge cost in order to care for the others, and the love and sacrifice are entirely real.

So we have this shift from being entirely egocentric to caring for others. How do we then get to morality, something that is recognizably within the domain of morality as we understand it, such as food sharing?

To me, at any rate, the clues come from the prairie voles. There are many species of voles, and I'm going to characterize two, the montane voles and the prairie voles. The montane voles are the stereotype of a rodent. The males and the females meet, they mate, then go on their separate ways.

Prairie voles are different. They meet, they mate, and they're bonded for life. What does that mean? It means that they stay together a lot. They do not like to be separated. It means the male guards the nest, which does not happen among montane voles. It means the male helps to rear the pups, huddling over them and protecting them. It means that they get depressed if they are separated. This bonding tends to happen immediately after the first mating and becomes even stronger after the first litter is born.

I should also just say that pair-bonding does not imply sexual exclusivity, and this is true in the 95% of bird species that are also bonded for life, such as Canada geese. Although it does not imply sexual exclusivity, much of the sexual activity does take place with the bonded mate.

In addition to that, prairie voles are generally very social. If you have a basket of them and you distribute them around a room, before very long, they come together. They just like to be together. Montane voles are not like that at all. Moreover, prairie voles live in these large communities, and the siblings frequently help in taking care of infants. We're seeing sociality that goes beyond just the bare mother-offspring relationship, and that probably involves a relatively small genetic change that is relative to the large genetic changes that result in care for offspring.

In order to understand the difference between montane vole and prairie vole brains, Larry Young and Sue Carter and a number of other people looked at their brains, staining them for receptors for oxytocin and receptors for vasopressin. The structure they were interested in is part of the reward system, the nucleus accumbens. In the prairie vole, there's a much greater density of receptors for oxytocin. The animals might all have the same amount of oxytocin in the brain, but the density of receptors on neurons to which the oxytocin binds is much greater. Same for vasopressin except in a different reward structure—the ventral pallidum.

The early discovery was only a correlation between receptor density and social behavior, but the neuroscientists took all of the additional steps needed to determine whether or not there was a causal relationship, and found there almost certainly was. I should, of course, also acknowledge the many other neurochemicals involved, in-

cluding serotonin, dopamine, the endogenous opioids, and the endogenous cannabinoids, the latter probably contribute to making us feel good in those happy social conditions.

What actually does oxytocin do? A number of things in the mammalian brain, I should say. There seems to be a contrast or opposition between oxytocin and stress hormones. To a first approximation, when oxytocin levels go up, stress hormones go down. Part of why you feel good in a social context amongst friends is that stress hormones go down. You don't feel anxious. When stress hormones go down, other things can also be regulated, and we think that the endogenous cannabinoids and the endogenous opioids are probably playing a role.

It looks like this extra part of sociality might come for free as a result of getting mate bonding, which just then spills over into feeling good about being in a social context in general, or it might actually involve a different set of receptors and different genes. There might be a slightly different story there, but we're not entirely sure.

Let's turn to marmosets, the tiny South American monkeys. They bond for life and the fathers take care of infants to a greater extent than females, and even alloparent orphans in the community. Surprisingly, perhaps, chimpanzees will do this, too. There is some evidence that the oxytocin story is important in the social behavior of other primates.

The basic thesis that I think emerges is that attachment and trust are the platform for moral values. Once that is in place, then other behavior such as cooperation and mutual defense can emerge. I should just say, too, that although this story seems very nice at this point, mammals are not, of course, free of all selfish considerations, and individuals within a group do not cease to be competitive, as with siblings. In all social animals, from time to time, there is within-group competition, but in wolves, for example, rough competition between individuals within a group is generally discouraged.

We know this is also true in some hunter-gatherer groups. It was definitely true amongst the Inuit until they were westernized. They allowed very formal kinds of games where especially the boys within a family could knock each other about, but they were not allowed to go at it in an informal way. You can see why that practice would emerge. There they are, living on the knife edge of survival, and you can't have a whole lot of energy wasted on stupid things like fighting. Every hunter and fisher is needed, so injuring or laming is unproductive.

Part of what emerges from this story is that you might not need specific genes for every kind of social behavior, such as cooperation or food sharing. Some forms of cooperation are just going to emerge because the animals are smart enough to see that, "These are my friends, and I can trust them, and we'll do better if we work together."

Wolves, for example, in the Yukon, call to attract other individuals from the pack. They know when there is a move afoot to go after prey. They trot off in a line and find a grizzly that has brought down a caribou. Possible food here.

Only by working together, however, can they drive off the grizzly. They will harass and harass and harass until finally the bear gives up, and then they feed. It's a very effective strategy. Wolves also use cooperation to bring down a deer or a caribou themselves and it's a most astonishingly organized phenomenon.

In scavenging, wolves sometimes get help from ravens. A raven can fly over the woods and see quickly where action is happening. When a raven knows there's some grizzly having downed a caribou way off, the raven return to the wolf pack and alert the wolves by flapping around and attracting attention. The wolves have come to know what that means—it's not genetic, it's learned—and the raven leads the wolves to the kill. What's in it for the raven? The answer is that once the wolves are settled into the caribou carcass, he goes and gets his pals, and they come with their razor sharp, long, terrifying beaks, and they harass the wolves until they drive the wolves off. Everyone, save for the caribou, wins.

This story involves a nested set of cooperation ventures: The wolves cooperate with each other, the raven cooperates with the wolves, and then the raven cooperates with other ravens in the flock. But these are different forms of cooperation. The wolves like and trust each other—they are bonded. Ditto for the ravens in the flock. But the ravens and the wolves are not bonded to each other. They have just figured out a system whereby wolves and ravens mutually benefit. It's a way to get good caribou meat.

With regard to rules and norms, many are like the how-close-to-stand norm. We abide by them, our behavior is guided by them, but they are implicit. When groups become much larger than 150 or so members, there may be a need for explicit rules. Nevertheless, it's very interesting that a lot of conventions, methods, social practices can be picked up just by imitation, by watching, by modeling yourself after what the other individual is doing. You may not even be aware that you're doing it yourself.

In the first instance, in these small social groups of early humans, *Homo erectus*, *Homo neanderthalensis*, and *Homo sapiens*, such loosely defined norms probably sufficed for much of what we needed for social stability, but with the advent of agriculture and the emergence of large towns where not everybody knew everybody else, norms began to be laid down, discussed, and pronounced from on high.

Also, humans at about that time really began to pick up on the fact that it was tremendously advantageous to trade stuff, especially to trade tools. If I make hooks, and you make nets, and we trade, suddenly my tool box has doubled. Once they began to realize that, trade really got going. Then there needed to be rules and norms and practices for what constituted fair trade and how those kinds of practices were enforced.

I haven't yet talked about the dark side, to do with between-group hostility. Anthropologists say they really do not know very much about between-group hostility in ancient prehistoric times. Some anthropologists think it was unlikely to have been common because there's not much advantage in it. If no one has very much, why

would I go on a raid to kill and steal—what would I get out of it? I don't have very much but I don't need very much. But of course, once wealth began to be accumulated, there is an incentive. Once there's wealth, once there's power, once there are inventions that allow you to get the upper hand, then we begin to see in full flower the emergence of aggression.

I find aggression really interesting and surprising and amazing. It's much older than other-caring, and in that sense, it's much more ancient than sociability. How exactly it plays into our lives, into our daily lives, why it emerges the way it does, is puzzling and interesting.

Not a great deal is understood about the neurobiology of aggression and in particular about this really rather disturbing but apparently factual relationship between aggression and pleasure. It's clearly there, but why? Why is hating especially bonding within a group of male adolescents or female adolescents? Why is hating pleasurable? There is speculation predation needs to be pleasurable in order to pull it off because it's pretty scary. If you're a wolf, and you're going after caribou, the likelihood of injury is high. Maybe you have to be in a state of excitement in order to be able to pull it off. This is just speculation, and we really don't know why the relationship is there, when in fact it is. David Anderson's lab at Caltech is studying aggression, and I hope to learn much in the coming years that will help us understand its neurobiological nature.

I want to end with a cheesy example, but I like it. We're always taught that orangutans are loners, and in the wild they are indeed solitary. That's largely because they are vegetable eaters, they need a very large territory, so in the wild they tend to be social only to the degree that the mums and the offspring stay together for 2 or 3 years. After that, they tend to be loners.

People have thought, "Isn't that interesting? They're probably not very social. They probably don't derive plea-

sure from company of others in the way that, say, baboons or humans do." But it seems that if conditions are right and resources are plentiful and available, the pleasure circuitry for enjoying the company of others in a trusting situation is all there, and it just spills over. In the Iowa Rescue Center for primates, Rusty the orang was just hanging out by himself until this old dog showed up and wandered into the facility, and they have been inseparable since.

YouTube has a plethora of examples of mother pigs suckling dogs and mother dogs suckling pigs, of an orphaned baby rhino becoming very attached to lambs, of owls and birds playing joyfully, of a bear, a lion, and a tiger cuddling together in close harmony. It's almost as though as mammals with our large brains we don't have to be so inflexible that we have to care precisely about every bit of energy going into making sure that our genes are passed on. It is fine to play and to enjoy the company of those who will not contribute to your inclusive fitness.

Does this happen in the wild? Again, if conditions are right, if times are prosperous, and the living is easy, animals can be very social.

There are wild dolphins off the coast of Florida which swim up and down the canals. A group of them found a dog stranded in a canal that had very steep sides, and the dog could not get out. It had been there for many hours, was becoming very weak. The dolphins went into the canal. The dog climbed on them and they take him to a place where there's a lot of people. The dolphins collectively make a huge amount of noise. The people come out, dog hops off, happy ending to the story.

This behavior is interesting because it's not conducive to passing on genes. It's got to be that circuits are there for pleasure and doing good and liking others and caring for others, and that the circuitry is sloppy. It's probably served sociality quite well that it's sloppy, even though, of course, there is great variability within a species of how social individuals are.

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