Science AMA series: Consoling behavior in rodents! I'm James Burkett, and I published a recent paper in Science showing empathy-based consolation in the prairie vole. Ask me anything about empathy and

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Abstract

Hi, I'm James Burkett, a neuroscientist at Emory University in Atlanta, GA. I worked under Larry Young and Frans de Waal on research that was just published in Science, showing for the first time that consoling behavior is not limited to large-brained animals with complex cognition. Consoling responses can be observed in the laboratory in rodents, specifically in the highly social prairie vole. In this paper, we proved that prairie voles console other voles in distress, and that they are motivated to do this by empathy for the distressed vole. We also showed that the brain mechanisms that support this consoling response in the vole are the same that are involved in empathy in humans. This is the strongest evidence yet that the fundamental building blocks of empathy are conserved in evolution between rodents and humans. In psychiatric disorders such as autism, schizophrenia, psychopathy, Huntington's disease and more, there are deficiencies in detecting and responding to the emotions of others. Yet, there are no medical treatments for any of these deficiencies. This is primarily because we have only basic information about how empathy works in the brain, due in large part to a lack of animal research on the topic. It is our strong hope that this research will lead to advances in the treatment of psychiatric disorders. Here is the original article at Science: http://science.sciencemag.org/content/351/6271/375 Here is an excellent article about it in The Atlantic: http://www.theatlantic.com/science/archive/2016/01/consoling-voles-reignite-debate-about-animal-empathy/425034/ Here is a cute animated interview about the article between Larry Young and a 4-year-old: https://www.youtube.com/watch?v=vGgWZai5IMQ AMA! I'll be back at 1 pm et (10 am PT, 6 pm UTC) to answer your questions, ask me anything! Edit: Hi everyone! I'm back from lunch seminar and ready to answer all your questions! Let's get to it! Edit 2: Wow, this has been great!! I'm taking a break for dinner, but I swear I'll be back later tonight to answer more questions.

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REDDIT

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JAMES_BURKETT R/SCIENCE

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Here is an excellent article about it in The Atlantic: http://www.theatlantic.com/science/archive/2016/01/consoling-voles-reignite-debate-about-animal-empathy/425034/

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AMA!

I'll be back at 1 pm et (10 am PT, 6 pm UTC) to answer your questions, ask me anything!

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CORRESPONDENCE:

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Excessive self grooming in mice has been used as amodel for obsessive compulsive disorder. The fact that the prairie voles do this as consoling behaviour does suggest grooming is comforting. But it also seems that in some strains of mice, but not all, barbering is thought to be a sign of dominance and/or aggression. How can you differentiate between a potentially comforting behaviour and an aggressive one? Are there any measures to suggest being groomed by a partner or cagemate reduces stress?

Also some simple questions probably answered in the manusscript (no access to full text at the moment) - was this a sex specific behaviour and did you look at vasopressin? In some behaviours of the prairie vole, oxytocin and vasopressin play sex specific roles.

James_Burkett , r/Science , Science AMA series: Consoling behavior in rodents! I'm James Burkett, and I published a recent paper in Science showing empathy-based consolation in the prairie vole. Ask me anything about empathy and , *The Winnower* 3:e145467.75200 , 2016 , DOI: 10.15200/winn.145467.75200

Accumbenz

A very important question! Obviously one of our primary goals was to show that the behavior we observed fit the common definition of "consolation" - which includes the idea that someone is "consoled," meaning stress reduction.

Indeed, we do see that stressed prairie voles that receive grooming from their cagemates show reduced anxiety afterward, as compared to stressed voles who sat in the familiar, calm environment of their home cage for the same amount of time. In fact, after receiving consoling, the stressed voles' anxiety was indistinguishable from that of voles who had never been stressed in the first place.

There were no sex differences in the behavior. Both males and females would console their stressed mates, siblings and cagemates. The only sex difference we saw was that females tend to groom each other more at baseline.

We didn't look at vasopressin, but that is a very interesting avenue for future study. I will point out, however, that the sex-specific roles of oxytocin and vasopressin may have been exaggerated! Recent research from Larry Young's lab has shown that oxytocin plays just as strong a role in bonding in males as it does in females. Whether this will also be true of vasopressin in females is unknown.

Estrogen seems to play a role in non sexual social behaviour of mice in both males and females (e.g. social recognition, regulating oxytocin expression, aggression) Is there any evidence to suggest a relationship between a species' sexual behaviour and [seemingly non sexual] social behaviour? Does sex have a role beyond pure reproduction?

Accumbenz

Sex may actually play an extremely important "non-reproductive" role in animal species that are considered monogamous.

In at least 95% of mammalian species, males and females get together only to mate, and then the female provides care for the offspring by herself. However, in those 3-5% of mammalian species that are considered "monogamous," males and females form long-term attachments, and may also share duties in the care of offspring and the maintenance of the nest. In prairie voles, we know that sexual activity plays a very important role in stimulating the initial attachment that forms between the mating partners. Among other mechanisms, this seems to be driven by oxytocin release in reward centers of the brain. The reward centers of monogamous species tend to be loaded with oxytocin receptors, which are the molecular sensors that detect and respond to oxytocin. Oxytocin is thought to enhance attention to social cues, meaning that monogamous species are paying much more attention to the specific social identity of their partners during sex. Thus, what would otherwise be a highly rewarding activity is instead a highly rewarding activity that was *shared* with a specific individual.

It is interesting to note that humans are also considered a monogamous species, and we are one of the few (if not the only) mammalian species where sex has become completely de-coupled from the fertility cycle of the female. In every other species, females only become interested in mating when they are in the fertile cycle of ovulation, a coupling that facilitates impregnation. This is not the case in humans - changes in female sexual interest are only subtly changed throughout ovulation. This evolutionary de-coupling may be due to the increased importance of sex in the formation and maintenance of long-term bonds between sexual partners.

Do you think their social structure and dynamics are affected by this behaviour? if so, how?

jalbertoa

Definitely! Prairie voles usually live in either pairs or a communal group with parents and offspring. In this kind of living arrangement, anxiety felt by one group member can spread to others, creating unease, stress, and reduced health for the whole group. Providing consoling to other group members in distress can benefit everyone by preventing this unwanted stress. In many different species, cooperative and altruistic behaviors seem to correlate with social structures like communal living, monogamous bonding and bi-parental care.

Consoling in chimpanzees has been studied extensively, where it has been shown to be one of the primary mechanisms of conflict resolution whereby peace is maintained. Indeed, in chimps, the alpha male is the most likely individual to provide consoling after a fight, which is thought to be related to his general role in "policing" in the group.

Good morning! (It's morning here now, anyway.) I was wondering if there's any research into inter-species empathetic (is that the right word?) behavior. What are the particular challenges with such research? Do you think it could lend any unique insights?

I wonder because I have both dogs and rats, and while generally they pretty much ignore each other, one pair seemed to have become very good friends.

curien

Interesting question! Some attention has been paid to consoling behavior by dogs toward their owners - basically the doggy version of the "feigned distress test." When either their owners or a stranger pretends to cry, dogs respond with sniffing, nuzzling and licking. This research was done by Deborah Custance and Jennifer Mayer in the UK.

Dogs are an interesting evolutionary case. For thousands of years, humans have been selectively breeding dogs for various traits, the primary one being the degree to which they can successfully understand and communicate with human owners. Research looking into differences between dogs and hand-reared wolves, for instance, might give us insights into what specific evolutionary changes in the dog allowed them to better understand human emotional cues.

Of course, we have examples of chimpanzees offering aid to other animals (wounded birds, for instance) going back many years, but the dog study may be the first experimental evidence of inter-species empathy.

You say that this is the strongest evidence yet that the evolutionary building blocks for empathy have been conserved between humans and rodents. What is the evidence this isn't a case of convergent evolution?

firedrops

That evidence comes in two pieces. First of all, the prairie voles not only show the same empathy-related behaviors, but they also show the same physiological responses and the same brain mechanisms. Second, many (if not all) of the species in between humans and rodents seem to show some form of empathy, though it is variably expressed.

Together, this suggests one of two things: (1) that rodents and humans have homologous mechanisms for empathy that are likely to be present in different degrees in many animals; or (2) that identical mechanisms for empathy arise through convergent evolution via deep homology with another, underlying, homologous mechanism, such as maternal care.

What is the current status of oxytocin-based therapies in psychiatry? I recall hearing about some early successes with nasal oxytocin for schizophrenia, for example.

AveyTare

Our paper's second author Elissar Andari, who also happens to be my wife, has done some groundbreaking work showing the potential that intranasal oxytocin has in humans as a treatment for autism. She published one of the first studies (and considered by many to be THE seminal study) demonstrating that intranasal oxytocin treatment given to autistic individuals improves not only dynamic social interactions, but also the social sentiments that these individuals feel during interactions. She recently showed that these changes are related to the effects of oxytocin within the brain on how social brain centers respond to social information. She is currently pushing this research forward in collaboration with Larry Young, in a way that may finally start bridging the gap between clinical research and therapeutic treatment.

Intranasal oxytocin continues to be studied for its effects on other psychiatric disorders, including schizophrenia, PTSD, and more. However, the strongest and most reliable effects of the treatment in humans are for individuals with autism.

The promise that oxytocin holds for the treatment of autism and other psychiatric disorders is really the reason that I do this research at all, and I am excited and humbled by the research my wife does every day.

Any observed changes to activity in the nucleus accumbens at any stage?

Accumbenz

We showed in the paper that there was no difference in activity in the nucleus accumbens when voles interacted with distressed vs. neutral cagemates. Beyond that, we actually had a lot of negative data for the nucleus accumbens from other experiments that we didn't publish. That nucleus, and the related medial prefrontal cortex (also a reward area), just don't seem to play a role, either in terms of activity or in terms of the oxytocin receptors there. We don't think consoling, and other kinds of empathy for negative emotions, are driven by feelings of reward.

So.... What exactly does consoling behaviour look like in a prairie vole? (I am imagining tiny little cups of tea and boxes of tissues).

Ruruchops

Prairie voles lick and groom other voles in distress, much the way your dog might. Consoling in other species looks different, for instance chimpanzees engage in hugging and embracing, very similarly to humans.

There are many species of rodents to choose from, why voles? Given your location I doubt you were watching them from the lab window!

nallen

Among rodents, prairie voles are exceptional animals. In addition to being highly social animals, prairie voles mate for life, share a nest with their mate, coordinate bi-parental care of the offspring, and often will not take on a new mate if their partner dies. Juvenile prairie voles will often stay in their parents' nest and help care for their younger siblings, creating a communal nest. We have learned a great deal

about the way the brain processes social information from studying the prairie vole, especially in contrast with a closely related Microtine rodent, the meadow vole. While they are physically identical to prairie voles, meadow voles are asocial, do not form bonds with their mates, and care for the offspring is provided only by the mother for a relatively short period of time. Many of the differences in behavior between these two species can be traced back to specific differences in brain chemistry.

While our voles come originally from Illinois (like me!), vole species are found almost everywhere on the planet. Georgia has meadow voles but also pine voles, another monogamous vole species.

Hi! Do you have any pets, and if so, did you choose them based on their ability to empathize?

sadfacebear

I grew up around animals, on the family farm. We mostly had cats, so I guess the answer is no, we didn't choose them for their empathy. ;)

Do some of the voles also show disorder typed behaviour such as lack of empathy or understanding?

And if so, are they subjected to a type of therapy like humans would?

mastaloui

There was a great deal of individual variation in terms of how quickly and how much the voles responded to their distressed cagemates. It might be interesting to follow up on the ones who scored low and see if there is something consistently different about them!

How did empathy vary amongst different voles? What factors were at play?

ThatGirlCalledRose

There was a huge amount of variation in how they responded. That's actually one of the benefits of using an outbred rodent (unlike rats and mice, which are generally inbred and identical). That gives us the opportunity to follow up on this variation and see what the causes were. Look for that in the future!

How did you get into this research? It seems like a very interesting niche area!

Do you see any voles that lack the capacity for empathy or that show the... 'vole equivalent' to autistic qualities? And do different individuals display differing amounts of empathy or have a preference for different consoling behaviours? Any gender differences?

On a side note, I have a pet hamster...do you think she has the capacity to empathise with me after I've had a stressful day of science?

MoodyStocking

Within the prairie voles, there was a lot of individual variation in how quickly and how much response they generated toward distressed cagemates. We're thinking now about how to address this variation and use it to determine what the causal factors are.

The meadow voles never really responded to the distress of their cagemates, but you shouldn't think of them as "autistic voles." Meadow voles are simply adapted to different social conditions where this kind of empathetic response is not beneficial.

We also didn't see any gender differences in the consoling response - both males and females consoled their mates, their siblings, and their friends. Females did tend to show more of the social grooming at baseline, though.

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Cool!

In your personal experience, would you say dogs tend to show a higher tendency of empathy then cats, and that people who want empathy tend to choose dogs? Or is it the other way around?

Mitch_Mitcherson

Dogs as a species are quite empathic, with each other and with humans. Dogs are known to console each other after fights, and to console their human owners when the owner is distressed. On the other hand, cats have never been shown to exhibit either of the two major forms of conflict resolution - reconciliation or consolation. They are probably the only major social species that does not reconcile after fights!

As for the personality types of the owners, that I can't say much about. Maybe cat people just like low-maintenance pets.

Numerous times I've read scientists denying that non-human species really feel emotion, claiming that humans are just projecting their emotions onto the animal's behavior.

- Is scientific opinion changing about animals having emotion?
- Does self-awareness play into animal emotions?
- Do you believe any animals *don't* have emotions?
- Is there any evidence for emotions in creatures we wouldn't expect to have any?

OvidPerl

For decades, scientists operated under the "behaviorist" tradition - explain behavior in terms of observable facts and phenomena, and don't infer mental states that can't be observed. There is a certain scientific value to that. However, the essence of the behaviorist position is not that you *deny* that animals have unobservable emotional or mental states, but that you *don't take a position* on whether they have such states. This subtle distinction has not always been well observed by scientists.

A growing number of scientists are now beginning to appreciate the *evolutionary continuity* of emotions, and therefore the value in attributing emotional states to animals. Animals that show the same behaviors, the same physiological responses, and use the same brain structures, are likely experiencing a similar emotional state. However, attributing emotional states to animals in this way still requires that we scientists *do the work* and show, through careful experimentation, that the behavior/physiology/brain structures are indeed overlapping, and that it is reasonable to infer a similar

emotional state.

This work has not always been done carefully, particularly in the field of empathy. Fortunately, our scientific team included Frans de Waal, who is the world's foremost authority on empathy in animals. Frans was the first to describe consolation in animals, by identifying and defining the behavior in chimpanzees in 1979. He helped us to craft a careful, methodical, rigorous series of tests that excluded all other likely interpretations of the observed behavior. He is truly an amazing man and we could never have done the study without him.

For quite a long time, the prevailing theory has been that consoling behavior was only seen in large-brained animals who also showed mirror self-recognition, precisely because it was thought that self-awareness and the ability to understand the situation of others was required in order to console others. However, our results seem to show that complex cognition is not a pre-requisite - that empathy is sufficient to motivate even small-brained animal species to console others, under the right conditions.

I think we will start to see a widening of the range of animals that are considered to have emotional states. For instance, a while back Peggy Mason published a study showing rescuing behavior in rats, which was immediately criticized because ants also show rescuing behavior. It was implied that rescuing in ants could never be based on emotion-driven helping behavior, because they are just insectiod automatons. But people fail to notice that these little automatons actually have *the largest brain-to-body size ratio* of any animal on the planet, with almost 15% of their body mass being inside their brain. I hope we start looking at all animals, no matter how small, with a more careful eye.

I realise this is primarily a biological study but has this given you any clues to the evolution of empathy?

Acolyteuk

We have theorized that empathy evolved from our natural instinct for parental care. In every mammal species, there is a mother that cares for the offspring during a period of time when they are quite vulnerable. That mother needs to be able to sense and respond to the physical and emotional needs of the offspring, and the mothers that can do that best will have offspring that survive and thrive. A few mammals also have bi-parental care, where the father also responds to the needs of the offspring. This is empathy in its most basic form. In at least some species, that ability to sense the emotional needs of others, and the motivation to respond to those needs, has adapted to be directed toward other adults. This is how evolution generally works - through slight modifications in systems that are already present for another purpose. Being able to sense and respond to others in need, particularly among highly social and cooperative animals that rely on each other for survival, provides a selective advantage that allows empathetic traits to evolve. Empathy is our evolutionary heritage, one we share with many animals and probably all mammals.

What do you think would be a logical next step with this research?

ajewe040

For me, the next logical step is to use this opportunity that we have in order to probe deeper into the biological/neurological mechanisms that create and support empathy. This is an area that we know almost nothing about, because we have lacked the animal models necessary to study it. Hopefully, once we know more about how normal empathy and emotional responding works in the brain, we can start to understand how it goes wrong in disorders like autism and schizophrenia, and maybe be able to produce some medical treatments.

Do younger voles seem more consoling than older ones? I lack the expertise & terminology to fully word my question, but I'm curious if it's at all similar to an innocent(naive?) Child & a jaded adult.

JonGSonOfTheDee

We didn't see any differences based on age, but we also didn't test very old voles. All of our subjects were between 2 and 6 months old. (Prairie voles are adults at 2 months and can live 1-2 years in captivity.)

Hello!

As fate would have it, our oxytocin focused social neuroscience lab at Yale University just discussed this paper in our lab meeting yesterday evening. Really interesting work to see, especially the molecular work indicating ACC mediation.

Why do you think this was mediated by ACC and not NA (given its previous role in mating behavior). Why do you think these two types of behaviors would be mediated by different areas when they seem pretty similar behavior-wise? Any postulations about circuits?

Also, (refer to fig 3) do you think that this behavior was mediated by familiarity of the animals? Why would empathy/consolation behavior be totally dependent on familiarity? This is not how it works in humans, at least.

Also, (refer to fig.2) do you think that this was stimulus specific, or that it was a heightened state of fear for the demonstrator overall. I.e. if you had played a novel tone to the demonstrator (not paired with shock) would they have reacted with fear, and would the observer also learned to fear that novel tone?

Thanks for any answers and thanks for doing an AMA!

jessicattiva

Great!! I'm glad that other scientists are reading my research and really engaging with it!

In answer to your questions:

1) We believe that the fundamental response when one individual sees another in pain or distress is a kind of emotional mirroring, usually called emotional contagion. This means that the observer reflexively takes on the emotional state of the other individual. You experience this when you see someone get injured/hurt, or when you see them crying. What is happening, according to human brain studies, is that the same brain regions that process your own feelings of pain and distress also activate to represent the pain and distress of others. In humans, this is driven by the "mirror system," which for pain and distress usually means the anterior cingulate and the anterior insula.

While the nucleus accumbens is vital for reward-driven behaviors (like mating) and attachments (like monogamous pair bonds), we do not believe that empathy for negative emotions is driven by reward. We don't yet know what is upstream or downstream of the ACC that enables consoling to happen, but that would be the next step.

2) Think about when you see someone crying on the bus. How likely are you to approach and console them? Pretty unlikely. But if you know that person, the situation totally changes. Empathy and helping responses are actually quite biased toward familiar/similar individuals in humans. Many experiments have shown that, in addition to being less likely to help a stranger, we tend to feel less empathy for people who are unknown to us, and even for those of different races. This is one of the most well-reproduced effects in empathy research, with the same familiarity bias being present in virtually every species that a tests exists for. Some primatologists even consider the "familiarity bias" to be one of the necessary criteria for identifying a behavior as consolation.

This may seem bleak, but there are also rays of hope. On the one hand, if you think we will end racism in our time, you need to consider that we're actually fighting against millions of years of evolution. But on the other hand, several clever experiments have shown that priming people with positive examples from other races, or even just a few minutes of cooperative interaction with a stranger, was enough to eliminate these inherent biases.

3) While we didn't do a control with only untrained animals, it's fairly well known that rodents habituate to unfamiliar tones very quickly. Nonetheless, the key piece of data you're looking for that shows that the observer isn't just afraid because of the tone comes from the coordination analysis. That analysis works like this: if the observer is just afraid because there is a novel tone, you would expect his/her fear responses to be randomly distributed while the tone is playing. However, if the observer is freezing in response to the other animal's behavior, you would expect those fear responses to occur primarily when the other animal is showing fear.

We saw that the fear responses of the observer overlapped with the responses of the demonstrator more than would be expected by chance, meaning that the responses were coordinated. This is what tells us that the observer isn't just afraid because of the novel tone, but because of the behavior of his or her companion.

Thanks for your questions! I hope I answered them well enough!

This is the strongest evidence yet that the fundamental building blocks of empathy are conserved in evolution between rodents and humans.

How do we know this a preserved behavior and not something that naturally emerges from social structure?

Breadlifts

Well, honestly I think it's both. I think that as mammals, we have certain homologous empathy-related capacities that are universally preserved, likely including at least emotional contagion. We may also have other capacities that emerge only when they are adaptive, and certainly consoling behavior is one of those. At the moment this is ambiguous, since we are really just at the beginning of being able to study empathy in animals in a rigorous way.

Love your paper, it's awesome to have you here!

In your article, you say that the unconditioned response shows that perspective taking is not a required component for empathy. Different researchers refer to perspective taking a little differently so I'm curious what you specifically mean by that, and why does the unconditioned response imply that? Humans can take alternate perspectives and mentalize without any prior exposure to the sufferer or the aversive stimuli, so do you mean something different than this?

smbtuckma

What the unconditioned response shows is that the consoling behavior is instinctive and not learned. This means that complex cognition is not *required* to generate a consoling response. We are not excluding the possibility that the behavior is cognitive necessarily, because we didn't actually do any tests for aspects of cognitive empathy. (Those tests may not even exist right now.) However, we are excluding the interpretation that empathy can only occur through cognitive processes.

Would you say that empathy is something that can be taught? Why or why not?

saragoss813

I think that we have a certain inherent, biological capacity for some forms of empathy. When we hear someone crying or in pain, we have an instinctive, felt response; that is inherent. However, what we do with that response, and how we learn to respond to others, can be taught and nurtured.

Most of us had the experience when we were young where we made another child cry, and a parent or other adult would point to them and say "look how you made them feel; how would you feel if someone did that to you?" What that parent is doing is using the child's inherent empathetic feelings to teach them something. That's the complex interplay between learned and instinctual.

Do prairie voles have more cortical folds than other rodents? I ask because usually increased sociality and increased cortical surface area ride together in the animal kingdom.

I'm also curious if you have any thoughts on the role of the vagus nerve in consolation? In both the giver and the receiver. I ask because of its role in the expression of emotion and stress.

I really like your study, and look forward to more work! Will you be at that Human and Animal Emotion conference in Sicily this year?

marsyred

Like most rodents, the prairie vole's brain is completely smooth. Their brain is about 40% larger in each dimension than a mouse's, though. I'm not sure if anyone has done a careful study of brain-to-body-size ratio using Microtine rodents.

I don't know much about the vagus nerve in consolation - time to do some weekend reading!

I'm still seeing if I have funding to go to Sicily! Maybe we can meet up!