Red-bellied lemurs maintain gut health through touching and 'huddling' each other

December 5 2017

Red-bellied lemur in the trees of Madagascar. Credit: Avery Lane, University of Helsinki

Scientists have found a direct link between physical contact and gut bacteria in red-bellied lemurs. Likely passed through 'huddling'

behaviour and touch, the findings suggest implications for human health.

The University of Oxford worked in collaboration with scientists from several universities, including the University of Arizona and Hunter College of the City University of New York (CUNY), on the research, published today in the *Journal of Animal Ecology*, to better understand causes of diversity within the animal's gut microbiome, the community of various bacteria that live inside the intestine.

These bacteria play a key role in both animal and human health, aiding digestion and tuning our individual immunity. The right mix of gut microbes set the parameters of our immune defence, blocking pathogens and informing our ability to recognise bacterial enemies, from friends.

Aura Raulo, lead author and graduate student at Oxford's Department of Zoology, said: 'In close social groups like red-bellied lemurs, social environment is key to immunity. Animals that touch each other more tend to spread microbes, both good and bad, but eventually frequent social contact leads to a synchronised microbiome. Because microbes tune immune defence, this can be seen as a form of cooperative immunity: Sharing microbial allies and enemies makes infections by opportunist pathogens less likely.

'When people with different gut microbiomes interact, they share their symbiotic bacteria through touch. This bacterial transmission can make us more or less healthy, depending on how compatible our guts are with our friends. For example, I might host a bacteria in my gut that is well-behaved, and fits my symbiotic gut community, but might turn out to be an invasive pathogen in another person who is not accustomed to it. '

Red-bellied lemurs are a very tactile, socially bonded species that live in small family groups of two to eight individuals, and spend a lot of time together. The study findings show that social groups of lemurs had

markedly similar gut microbiomes and even within groups, individuals shared more similar gut community with their closest friends.

Red-bellied lemur, Madagascar. Credit: Avery Lane, University of Helsinki

The researchers suggest that sharing a similar microbiome within a social group may have a positive health impact, essentially harmonising the immune defence and preventing members from contracting dangerous infections. Since social bonds were associated with gut microbiota, information about gut bacteria could also be used to reconstruct the social network of their hosts: who's been in contact with whom.

'The gut microbiome of red-bellied lemurs most closely resembles that of their group members. They are extremely cohesive and in contact a great deal, and rarely if ever interact with other groups, so this makes sense,' explains Andrea Baden, assistant professor of Anthropology at Hunter college, and co-senior author of the research. 'This explains a great deal of individual variation, but genetic kinship might explain some as well. We know that infants inherit a suite of microbes from their mother, during birth, for example. Since red-bellied lemurs leave their natal groups to form their own groups when they become adults, they might retain some bacteria from their natal family group. We can trace that by looking at kin relationships in the population, and similarity of the gut microbiome in kin.'

While the initial findings show clear patterns emerging, there are some challenges to this work:

Stacey Tecot, co-author and Associate Professor in the School of Anthopology at the University of Arizona, said: 'At this point our research cannot tell us whether the bacteria are good or bad, or exactly what they are - since many are still unknown to science. To connect these results to immunity, we need to be able to distinguish pathogenic (or potentially pathogenic) microbes from beneficial ones.'

The study includes some preliminary data around the relationship between social environment, social contact, bacterial transmission and hormonal changes, such as stress. The team are currently working to build on their initial observations, with new research understanding how an individual's levels of the stress hormone cortisol are affected by their gut microbiome, as Aura explains: 'Social contact, stress physiology and gut microbiome are all intensely related. Your social contact defines how much stress you interact with, and both can influence the cocktail of microbes in your gut.

'Just like lemurs, people find social situations, such as competition sometimes stressful. However, primates also cope with stress through social means, by seeking and giving affection, grooming and touching each other, and so do people. This way, social contact also balances stress. Regardless of whether they are blood relatives, people that live in close quarters, also come to share similar gut bacteria. Synchronized physiological systems make us work more 'as one'. For example, bird pairs that have synchronized hormone levels are known to parent better as a co-operative unit. Moving forward we will be looking at how this physiological synchronisation affects cooperation in lemurs.'

In addition to the benefits of sharing the same microbiome, the authors are keen to understand how this knowledge can benefit human society, and potentially prevent the spread of autoimmune disease. Aura Raulo added: 'It is important to understand what builds up a healthy gut microbiome, and the role that the wider social and ecological environment plays in this. Understanding that social environment and stress are directly linked to gut microbiome, could go some way to explaining why the western world experiences so many epidemics of autoimmune diseases, and help us to better treat people with them. Microbiome is the link between our internal physiology and the external ecosystem that together should tune us to understand our limits. When tackling modern epidemics of autoimmune disease, we cannot ignore the environmental problems our ecosystem is facing, nor the social problems our culture is facing.'

More information: 'Social behaviour and gut microbiota in red-bellied lemurs (Eulemur rubriventer): In search of the role of immunity in the evolution of sociality' DOI: 10.1111/1365-2656.12781

Provided by University of Oxford