



## Gut feeling: How intestinal bacteria may influence our moods

Researchers beginning to understand link between gut bacteria and mental health

Sharon Oosthoek · CBC News · Posted: Jul 14, 2014 5:00 AM ET | Last Updated: July 14, 2014



Researchers have discovered significant links between intestinal bacteria and people's moods. (Shutterstock)

Mounting evidence that gut bacteria affect mood and behaviour has researchers investigating just how much power these tiny microbes wield over our mental health.

"Many people with chronic intestinal conditions also have psychological disturbances and we never understood why," says McMaster University gastroenterologist Dr. Stephen Collins.

Now, scientists such as Dr. Collins are starting to come up with answers.

Our lower gastrointestinal tract is home to almost 100 trillion microorganisms, most of which are bacteria. They are, by and large, "good" bacteria that help us digest food and release the energy and nutrients we need. They also crowd out bacteria that can trigger disease.

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*- Gastroenterologist Dr. Stephen Collins*

But when things go awry in our guts, they can also go awry in our brains.

Up to 80 per cent of people with irritable bowel syndrome experience increased anxiety and depression. And those with autism — a syndrome associated with problems interacting with others — are more likely to have abnormal levels of gut bacteria.

Dr. Collins and fellow McMaster gastroenterologist Premysl Bercik have done some of the seminal research into the bacteria-brain-behaviour connection. In a study published last year, they changed the behaviour of mice by giving them fecal transplants of intestinal bacteria.

It involved giving adventurous mice bacteria from timid ones, thereby inducing timid behaviour. Before the transplant, adventurous mice placed in a dark, protected enclosure spent much of their time exploring an attached bright, wide-open area. After the transplant, they rarely ventured beyond their enclosure.

The researchers also did the reverse — transplanting bacteria from adventurous mice into timid mice, which then became adventurous.

The mice's brain chemistry gives some insight into what might be going on, says Dr. Collins. The newly adventurous mice had increased levels of a naturally occurring chemical called brain-derived neurotrophic factor (BDNF), which is linked to reduced anxiety. The newly timid mice, on the other hand, saw their BDNF levels drop.

## **Investigating probiotic potential**

But mice are not men. Nor are they women. How well can mouse studies predict bacteria's effect on our own moods and behaviours?

Dr. Emeran Mayer, a gastroenterologist at University of California, Los Angeles, is a self-described sceptic, but admits "there is enough there to make me think some of the findings

from animal studies can be extrapolated to humans."

Dr. Mayer and his team were the first to establish a concrete connection between gut bacteria and brain function in humans. Their study, published last year, was funded in part by Danone Research, a division of multinational food company Danone.

The researchers gave 12 healthy women fermented milk containing a probiotic supplement made up of five different strains of bacteria thought to have a positive effect on the intestines. The women drank the milk two times a day over the course of four weeks. Another group of 11 women drank milk without probiotics.

Mayer scanned both groups' brains before and after treatment, while showing them photos of people with emotional facial expressions such as anger or fear.

The women who drank probiotics showed a reduced brain response to the faces, compared with the women who weren't given probiotics.

"So what does that mean?" asks Dr. Mayer. "You could say the group with probiotics perceived negative emotions as less threatening. They had a decreased brain response to stress."

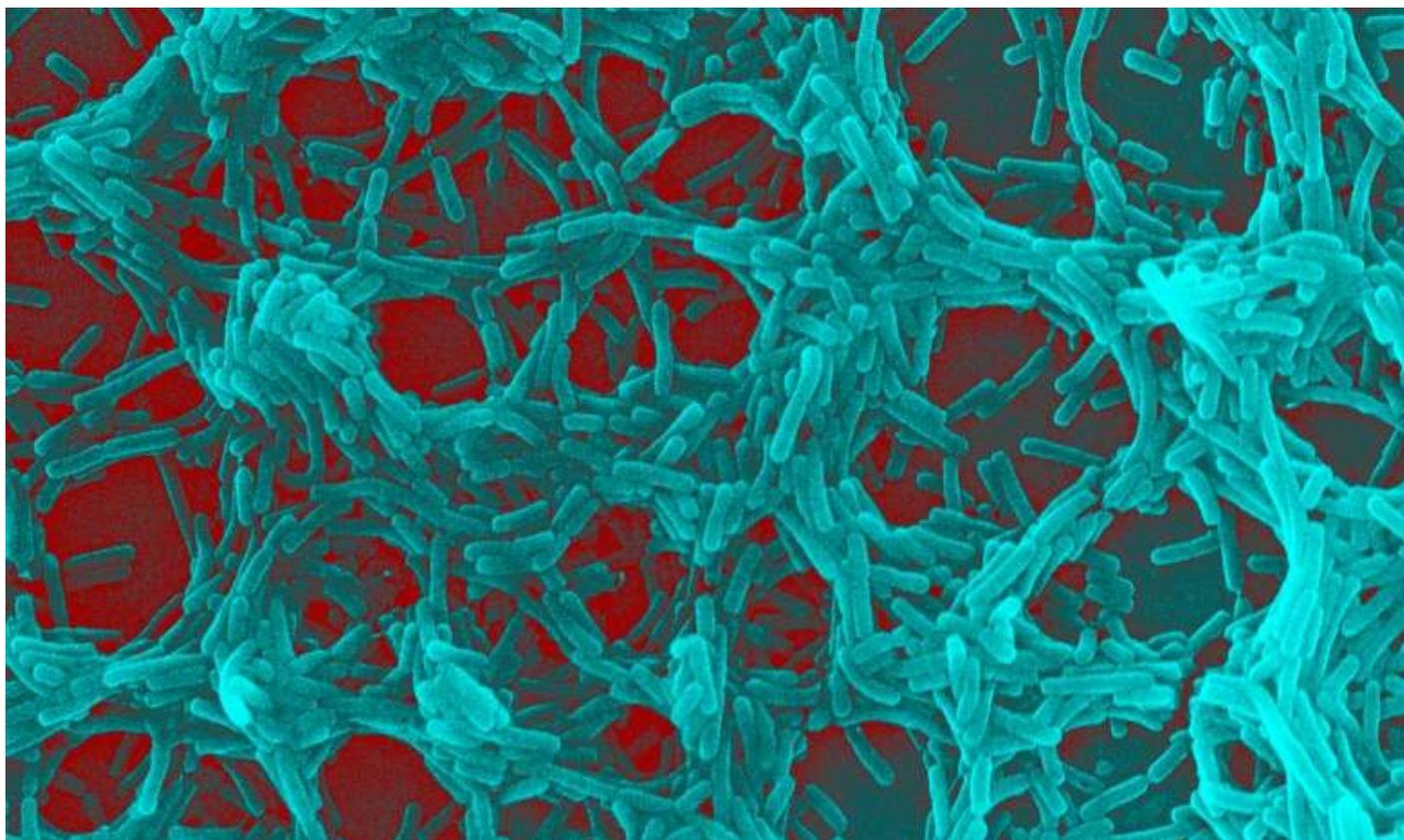
While the probiotics group did not report changes in their emotional state after treatment, they didn't suffer from stress or anxiety to begin with.

Dr. Mayer and his team plan to follow up with studies testing the impact of probiotics on those with high anxiety. In a separate study, they are looking into the potential effect of fecal transplants in children with autism.

## Bacteria-autism connection

Elaine Hsiao, a neurobiologist at the California Institute of Technology, is also delving into bacteria's influence on autistic behaviour. Hsiao and her team published a study last year about autistic mice that supports the theory that changes in gut bacteria can affect certain autistic behaviours.





Researchers say they need more studies to better understand which bacteria are good and how many bacteria are necessary to make a difference in a person's mental health. (The Associated Press)

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As is the case with humans, autistic mice have abnormal levels of bacteria in their guts. But after feeding them applesauce laced with the gut bacterium *Bacteroides fragilis* for three weeks, Hsiao found the levels of several species of bacteria in the mice's guts returned to normal. More importantly, some of the animals' autistic behaviours changed.

Before the treatment, Hsiao's team gave the mice three behavioural tests.

In one test, mice were placed in a box attached to two other boxes. One contained another mouse; the other a toy. Mice could choose to play with the toy or the mouse. Mice without autism showed normal social behaviour by playing with the mouse. Autistic mice, by contrast, preferred the toy.

A second test measured communication. Mice "speak" in the ultrasonic range, which humans can't hear. Hsiao recorded their calls using a special microphone that can pick up ultrasonic frequencies.

"The autistic ones produced fewer calls and the calls were shorter," she says. In other words, they communicated less than normal mice.

Finally, she placed mice in a bin containing wood shavings and a few marbles. In the wild, mice normally bury things. Hsiao's autistic mice did indeed bury the marbles, but they then dug them up and reburied them — over and over.

After eating the applesauce with *B. fragilis*, the autistic mice stopped compulsively burying marbles. They also communicated like normal mice. What didn't change, however, was their preference for toys over other mice.

## Changing brain chemistry?

Exactly how bacteria alter mood and behaviour — in mice or humans — remains unknown. One theory has to do with bacterial waste called metabolites. Bacteria feed on nutrients we ingest with our food, and like people, bacteria don't use everything they eat. Whatever doesn't fuel their growth and reproduction, the bacteria expel as waste.

That waste gets into the blood and probably into the brain, changing its chemistry. And chemical activities in the brain underlie mood and behaviour.

Another theory is that gut bacteria, or their metabolites, somehow communicate with the brain over the vagus nerve, a long nerve that runs between the gut lining and brain.

Regardless of how the change takes place, it may be that good bacteria can help alter mood and behaviour. But researchers say we need more studies to better understand which bacteria are good and how many bacteria it takes to make a difference.

"By understanding how humans interact with their trillions of bacterial inhabitants, we might one day be able to develop better treatments for behavioural disorders, including depression, autism and anxiety," says Hsiao.

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