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The big idea: can what you eat change your mind?

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Probiotic drinks, brain-boosting superfoods, gut-healthy snack bars: every day we're bombarded with information about what and what not to eat. Some foods move abruptly between these categories depending on who you ask: if a gut-healthy snack bar is ultraprocessed, does that cancel out its benefits? You'd be forgiven for thinking that every food choice you make has immediate, direct consequences for your health. And, increasingly, your brain. Does broccoli make you brighter? Can a pickle really act as a pick-me-up?



There is some scientific truth to this magic. By now you may have heard that people with poorer mental health, such as those experiencing depression or anxiety, have a different balance of bacteria in their gut – a reduction in the richness and diversity of their microbiomes. This fits neatly with elegant (albeit slightly gross) experiments in the lab in which transplanting faeces from people with depression into rats induces "depression-like" behaviours. How is this possible? It's because your gut sends signals to your brain via the vagus nerve, your immune system, and other means, passing on information about how things are going down there. And so, the theory goes, a less-diverse microbiome might be the cause of a depressed or anxious brain. Maybe a guthealthy snack bar really would help? Maybe. But the bacterial world we live in is not so neat. Your microbiome, unlike the microbiomes of rats who live in a germ-free lab, is messy. It is affected by many factors other than the snack you just ate, including your genes, your history of taking certain medications, and even your social interactions – every day, throughout your life. Disentangling cause and effect is tricky. A person with poor mental health might have a less-diverse microbiome simply because they are alsomore likely to have eaten a less-diverse diet, interacted with other people less, or taken antidepressants. Probiotics can help your gut microbiome diversity, but whether or not this is enough to influence most people's mental health is unclear.

And, in any case, the brain is far from being merely a passive receiver. Signals from the gut are filtered and changed by the brain itself: dampeneddown or enhanced by neural pro-

cesses. The sway your gut holds over higher processes is subject to your brain's state, its priorities and its predictions. Ultimately, it's the brain that matters.

And what matters most to the brain is survival. Signals from the body are incorporated in your brain's broader representation of the world – the world around you, and the world inside you – so that it can monitor and adjust your behaviour in order to help you survive. In the case of food, two types of information are absolutely vital for survival: does something you eat contain energy your body can use? And does it contain something that might make you ill?

When you take a sip of a sugary drink, your brain processes the sensory information – the taste, bubbles on the tongue, and so on. But it doesn't stop there. Once you've swallowed, your digestive system tells the deep reward structures of the brain – via the vagus nerve again – that what you've eaten has calories. You also register that it's hydrating. These signals reinforce your behaviour: they tell your brain to pursue that particular drink again in future.

This is an ancient form of rewardbased learning. It keeps us alive. It helps us find foods that satiate us and drinks that quench our thirst. It also happens unconsciously: when you're at the shops thinking about which food might
be better for your brain, your brain is also subtly, secretly, influencing your decision based on its experience with rewards in the past.

Your life's experience of food and drink differs from mine, so the information built up about reward is somewhat idiosyncratic. Not only that, but different brains can be more or less sensitive to food-related signals from the body. This means people adjust their energy intake (via eating) or expenditure (exercise) to different degrees. Most of the genes commonly associated with obesity act in the brain, and some of the appetite-reducing effect of drugs like Ozempic may be due to altered dopamine signalling.

So much for the things you like, what about the things you hate? As with rewards, we differ in our sensitivity to punishing, aversive signals from the body, such as nausea. And just as our brain learns from internal signals what it needs to keep us alive – things that contain calories, fat, hydration – it also learns what to avoid in order to keep safe from illness. That's why, once something has made you sick, your brain learns strongly and rapidly to steer clear of it. One Sunday, I went out for a lovely brunch of smoked salmon and scrambled eggs. I then developed a horrid case of food poisoning. Nausea and vomiting are a kind of internal punishment – a clear message from the gut to the brain that we've ingested something bad.

It seems likely that once we have a disgusting experience with something, it is much more difficult to "un-learn" than other sorts of experiences that typically lose their potency over time. In other words, disgust may be stickier than other emotions. To this day I am repelled by the thought of eating scrambled eggs and smoked salmon together, even though it's relatively unlikely I'd get sick from them again.

Disgust can be a blessing when it helps you avoid something potentially poisonous. But it can also be a burden, underpinning phobias, food avoidance, and some types of posttraumatic stress. Sometimes, your brain needs aversive signals from the gut in order to ensure

you stay healthy, but sometimes, their influence could do with dampening down. Recently, neuroscientists in Aarhus, Denmark found that stomach-brain coupling was enhanced in people with heightened symptoms of stress, anxiety, and depression.

So can what you eat change your mind? In a sense, yes. The most extraordinary property of the gut-brain axis is that it is plastic. In the same way that your brain constantly takes in new information about the world around you, strengthening or changing connections via neuroplasticity, it also adjusts to signals from inside you. Dodgy leftovers, or a specially formulated drink that nudges your microbiome one way or another, might indeed have a measurable, or perceivable effect. Precisely how food influences your mood and wellbeing, however, depends critically on your particular brain: its past experience of reward and punishment, its genetically and environmentally influenced characteristics. There's no one size fits all answer, so beware of any strong claims. What we know for sure is that, whatever's on the menu, your brain really is listening to its gut.

Further reading

Gut by Giulia Enders (Scribe, £12.99) Dark Matter: the New Science of the Microbiome by James Kinross (Penguin, £20)

The Inflamed Mind: a Radical New Approach to Depression by Edward Bullmore (Octopus, £9.99)

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