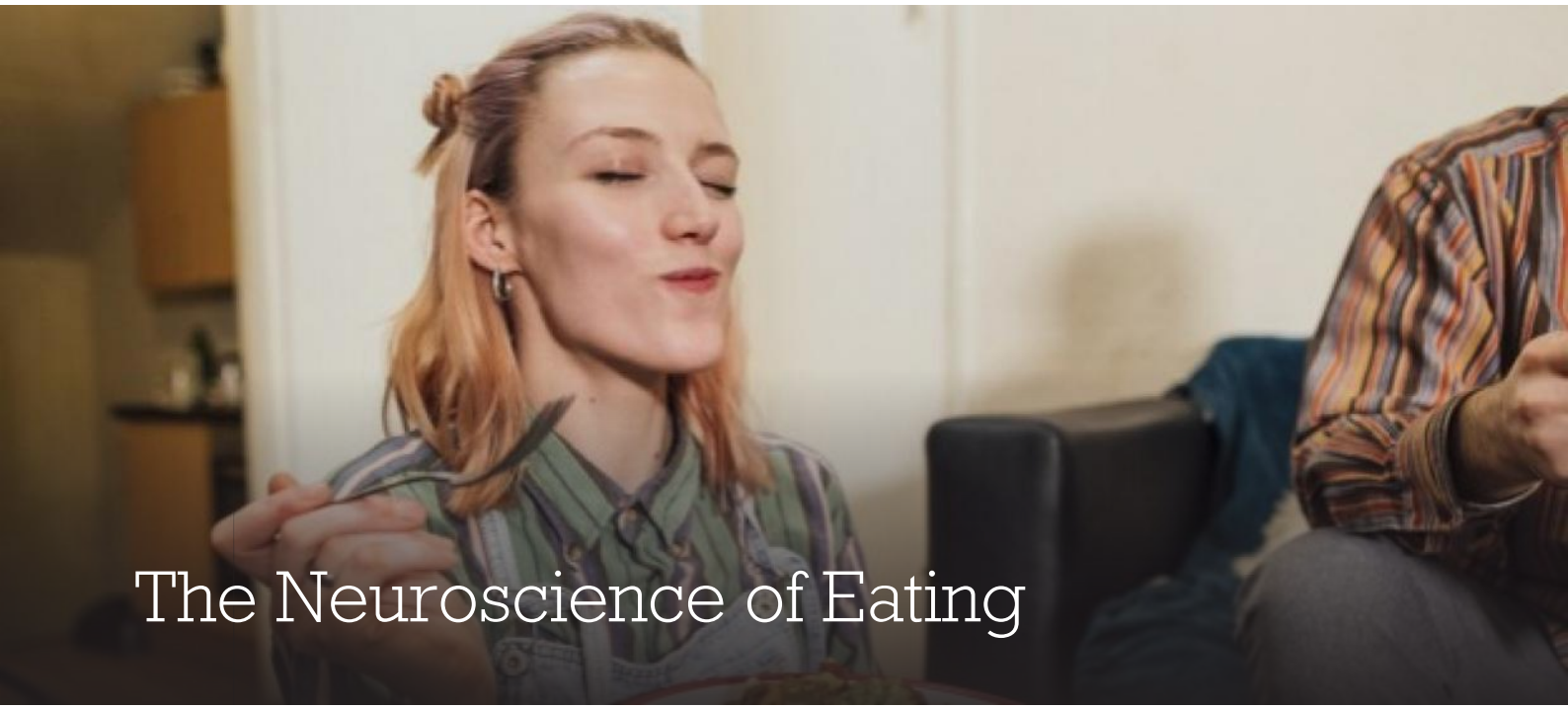

The Neuroscience of Eating

An entire biological ecosystem – encompassing complex connections between our gut and brain – underpins our daily food choices.

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The global obesity epidemic is striking for its prevalence and persistence. Despite mounting attention from the media and governments, obesity rates have risen in **every region of the world** in recent years. Deeply entrenched attributes of contemporary lifestyles, from the worldwide availability of unhealthy processed food to the sedentary nature of urbanised lives, are often thought responsible. That helps explain why reducing obesity has proved so difficult. But it does not make the epidemic's effects on lives and public coffers any less devastating, or more acceptable.

Hilke Plassmann, Octapharma Chaired Professor of Decision Neuroscience at INSEAD, believes that our efforts to combat the obesity epidemic could be much more effective if we took a holistic view – that is to say, a neuroscientific view – of food choice. In an interview for **the INSEAD Knowledge podcast**, Plassmann argued that the usual view of weight management as a clear-cut calorie-counting exercise neglects the role of "certain factors in our biology that are biasing this equation of calorie intake and calorie outtake".

Specifically, Plassmann is interested in how the complex interrelationships between our gut and brain affect our food choices. If we understood this system better, we might be able to hack it. And that would give us stronger weapons than mere willpower to use against the obesity epidemic.

Obesity research

A major premise of most mainstream approaches to tackling obesity is that bad food and lifestyle choices are behind it. Healthful-living campaigns, for example, often try **to shock and educate** the public about the risks of reckless eating so that they'll make "smarter" choices. However, Plassmann's recent research (with **Pierre Chandon**) suggests that such approaches may be more effective at preventing obesity in lean people than at helping people with obesity become lean.

Bariatric surgery is an abrupt, effective intervention for obesity that circumvents food choice. Plassmann compared the pre- and post-surgery responses of people with obesity to food marketing cues, as well as the connectivity of their brains' reward system, to those of lean people. On both counts, participants with obesity who underwent the operation became much more similar to lean people than they were before the surgery.

For Plassmann, this indicates that "this state of being obese is related to a biological state that influences the brain's valuation and rewards system and how it

functions''. In other words, there is something about obesity itself that suppresses willpower on a biological level. Just as it's harder to walk a straight line after drinking several glasses of wine, obesity impairs one's ability to make self-benefitting trade-offs between pleasure and well-being.

The eating-thinking connection in the gut

The linkages between the food we consume and the ways in which we make decisions go beyond *how much* we eat. An evolving body of research explores how bacteria composition and hormonal activity in the gut communicate with the brain and vice versa, possibly helping to determine our overall health and well-being.

In a recent review paper for ***WIREs Cognitive Science***, Plassmann summarises what is known about the gut-brain connection regarding systems involved in food choices. One critical aspect has to do with the peptide hormones in the gut. ''There are two hormones called leptin and ghrelin, that are our hunger and satiety hormones. The satiety hormone, once I start eating, should tell me in theory, 'Okay, Hilke, you have eaten enough so you should stop.' I say 'theory' because if the system would work that way, there would be no obesity, right?'' Plassmann said.

Researchers are learning more about how these hormones affect how we choose, for example, between a fruit salad or chocolate cake for dessert. In her recent ***Brain Communication*** paper, she found that a change in brain connectivity at rest in the brain's valuation system correlated with a change in baseline leptin after a weight loss intervention.

Gut-brain research implies that an entire biological ecosystem impacts our daily food choices. Homeostatic hormones, for example, trigger the production of the neurotransmitter dopamine in the brain, which in turn helps determine how much of a given food we consume. Previously, scientists thought that taste alone was responsible for the release of dopamine. More recent studies have challenged this hypothesis.

For instance, **a 2019 paper** found that after drinking a milkshake, participants experienced two dopamine peaks: one right away, and another 15 minutes later. This suggests junk food triggers happiness both at the beginning of consumption and when it hits our digestive system. Another study from 2011 found that the hunger hormone ghrelin decreased much more sharply in participants who were told they were drinking a highly caloric milkshake as opposed to a less fattening one, even though the two treats were actually identical. ''This is amazing because this means if I'm drinking a diet product, this label, this cognitive belief about it, it's fooling my gut system'', Plassmann said. People might eat or drink less if they received the opposite message, i.e. that the diet soda or ''healthy'' food option was actually indulgent or bad for them.

Finally, and perhaps most relevant to the obesity epidemic, the composition of the gut microbiome, or bacteria in the gut, may affect reward processing and decision making in the brain. It's unclear exactly how this happens. Potential channels may include metabolites such as short-chain fatty acids, bacterial modulation of the neurotransmitters tryptophan and serotonin, or even the immune system.

Nonetheless, there is mounting evidence of gut bacteria's connections to cognition. For example, a 2017 ***PLoS One*** **paper** reported that the stools of ADHD patients contained elevated levels of *Bifidobacterium*, which is associated with a gut microbial enzyme shown to suppress activity in reward-processing centres in the brain.

Plassmann's forthcoming research looks at what happens to people's reward-based choices when their gut microbiome is adjusted for the better through **synbiotic supplements**. Results have been promising so far. ''[The supplement regimen] not only changed the microbiota composition, it also changed their patience to receive a reward'', she said. In principle, this more conscientious mindset should extend to food as well, improving people's ability to control cravings and motivating more healthful choices on the whole.

The feedback loop

Viewed through the gut-brain framework, food choice is less an independent calculation than the outcome of a feedback loop in which what we eat today implants, at a biological level, the seeds of future meals. On one level, this carries the discouraging implication that existing obesity sufferers – barring serious surgery – will have to battle their own biology to better their metabolic state.

In another sense, though, the gut-brain connection is rife with positive possibilities. It points to numerous areas of intervention beyond appeals to willpower. This includes synbiotics to target the gut microbiota composition or supplements that raise serotonin levels, tracking of metabolic base rates and stress levels etc. Further research and experimentation may refine these methods such that they become viable alternatives to invasive weight loss interventions such as surgery for some.

According to Plassmann, the more research reveals about the physiological components of food choice,

the clearer it becomes that the fight against obesity will require societal approaches based on "precision wellness, to really try to understand in depth a person's behaviour but also their biology". This syncs with the broader trend towards healthcare interventions tailored to the individual, with the help of genomic tests and new technology such as wearables. As researchers discover more about the neuroscience of eating, don't be surprised to see brain scans and gut bacteria analysis added to the **evolving precision-health portfolio**.

Hilke Plassmann *is the Octapharma Chaired Professor of Decision Neuroscience at INSEAD. She is a principal investigator at the Paris Brain Institute (ICM) of the Sorbonne University, as well as the co-director of the* ***Business Foundations Certificate*** *(BFC) a programme INSEAD offers in collaboration with Sorbonne Université.*

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