Microbiota

Does our gut microbiota impact our thinking?

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What does food really mean for human beings? Does it simply provide the body with the "fuel" needed for life, like petrol in a car? We don't need to be researchers to recognize that this statement is somehow incomplete. We only need to be curious enough to observe that what we require for thinking, creating, feeling, or doing is not proportional to the amount of food we eat – a full belly is more often accompanied by feeling fatigued than by thinking innovative thoughts!

The dynamic view of nutrition developed by Rudolf Steiner in the early 20th century already gave indications that our capacity as human beings to connect our thinking and our actions is affected by the quality of the food we consume (Pfeiffer 1956). As far back as 1920, Rudolf Steiner was referring to the brain-gut axis in his lectures for doctors (Steiner 2020). What indications are we finding in current scientific research?

We can begin by considering the deterioration of cognitive abilities in human beings, which has been increasing around the world since the second half of the 20th century (Carrillo et al. 2019). In broad terms, cognition can be characterized by cognitive functions such as: sustained attention (the ability to maintain attention on something for a long period), selective attention (the ability to focus the mind on a specific thing), immediate memory (the ability to maintain a small amount of information for a short time period), and working memory (the capacity to store and manage information for performing complex cognitive tasks such as language, reading and mathematics) (Carrillo et al. 2019). The worldwide increase in cognitive deterioration has most often been associated with degenerative diseases such as Alzheimer's or dementia that, according to the World Health Organization (WHO), affect a new person every 4 seconds. Cognitive impairment has therefore become an increasing societal burden that we are called upon to overcome. Certainly, a first step might be to better understand the relationship between cognition and the food we consume.

In contrast to 1920 when Rudolf Steiner held the first lectures for doctors, the existence of an interrelationship between the brain and the gut microbiota, what is called the "brain-gut-microbiome axis" (Borre et al. 2014; Evrensel et al., 2015; Carabotti et al., 2015), is fairly well established today. It turns out that the human intestinal tract is, in fact, a huge ecosystem containing about 38 trillion gut microbial cells (Sender et al., 2016). As described by Carabotti et al., 2015, the brain affects gut function via the hypothalamic-pituitary-adrenal axis and the autonomic nervous system. For example, norepinephrine released by the brain during periods of stress stimulates gut pathogen proliferation. Conversely, the gut microbiota can affect the central nervous system by producing a variety of metabolites and products – neuroactive substances and hormones that traverse the enteric nervous system, vagus nerve, circulatory system or immune system to reach the brain (Liu et al., 2022).

Thus, a host-associated microbiota – where microorganisms occur inside and on host surfaces – plays an important role not only at a physiological level (gastrointestinal function, immunity and metabolism) but also at a behavioral level, such as in social, communication and cognitive behaviors, as shown by Vuong, et al. 2017 in their research with lab animals and animals in the wild. The gut microbiota intervention studies done on human populations, which aimed at improving cognition or brain function, resulted in improvements in visuospatial memory, verbal learning and memory, and aspects of vigilant attention. In addition, certain single- or multi-species probiotics and prebiotics have demonstrated an ability to interact with the brain and elicit a positive bacteria-cognition relationship (Tooley, 2020; Lew et al. 2018).

Furthermore, as reported in Bagga et al. 2017, 2018, the gut microbiota plays a role in regulating mood, anxiety, pain and intuitive decision making. For example, a probiotic taken for 4-5 weeks was shown to influence the emotional decision-making process, also known as the intuitive or "gut decision" process. Lew et al. 2018, observed that administration of probiotics was accompanied by enhanced memory and cognitive traits such as social emotional cognition, verbal learning and memory. The cognitive outcomes of another study (Roman et al., 2018) showed a significant positive effect of probiotic treatment on decision-making processes and in particular, a reduction of impulsive behavior in a population diagnosed with fibromyalgia who received probiotic treatment for 8 weeks.

In another study, the NU-AGE dietary intervention project researched the effect of following a Mediterranean Diet for 12 months on the microbiome and the health of elderly individuals aged 65–79 years. The Mediterranean Diet regime consists of increased consumption of vegetables, legumes, fruits, nuts, olive oil and fish and low consumption of red meat. The results confirmed that there is a significant association between adherence to the diet and beneficial changes in gut microbiome composition and therefore in overall cognitive ability, episodic memory and physical well-being.

So we find that many researchers agree: lifestyle factors, like nutrition, represent crucial targets in preventing cognitive decline. In addition to the intake of probiotics and other special products, it was observed that a high daily intake of fruits and vegetables leads to better cognitive performance due to their rich polyphenol content (Haskell-Ramsay et al. 2022). As reported by Carrillo et al. 2019, these compounds act to improve neuronal plasticity, blood nitric oxide levels and oxygenation. In fact, different studies from 23 developed countries showed that polyphenol consumption decreases the rates of dementia, depression and Alzheimer's disease.

It is worth noting, therefore, that agriculture management practices have been shown to impact phenolic levels in fruits and vegetables (Veberic, 2016). Organic food is often characterized by higher phenolic content, as demonstrated in a two-year trial with the leaves and fruits of four apple cultivars (Petkovsek et al. 2010). Similarly, biodynamic and organic mangoes, as compared to those grown conventionally, showed a significantly higher flavonoid content (Maciel et al. 2011). Heimler et al. 2011 compared different production systems (conventional, organic and biodynamic) and found that the highest content of polyphenol was observed in Batavia lettuce (*Lactuca sativa var. capitata*) grown under biodynamic conditions. Bavec et al. 2010 also observed that biodynamic

beetroot (*Beta vulgaris*) had the highest phenolic content followed by beetroot grown under organic conditions, with the lowest amount found in conventionally grown beetroot.

So the type of food we consume as well as its quality has an impact on the gut microbiota, and this in turn is linked to a healthy mind and cognitive capacity. There is certainly more to consider here. For example, what about additional factors that might influence gut microbiota like movement, mediation and stress avoidance? And we should be careful to not jump to ascribing particular states of mind or disease to the microbiota, or cognitive performance to specific secondary plant substances. Nevertheless, what we have found is a distinct correlation between agriculture, food, gut microbiota, cognition and health that is worth researching further. This connection suggests that it is not individual factors or nutrients that produce an effect, but it is always an interaction, and if one part of the whole is not complete, the whole cannot be complete.

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