

Gut is a special sense organ similar to other special senses

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Abstract

Gastrointestinal tract (GIT) and Central Nervous system (CNS) are governed by neural regulation (Long and short neural reflexes in GI tract), which is surprisingly complex. In GI tract, the functions of gut are entirely mediated by Enteric nervous system (ENS). But some of the GI functions are highly dependent on extrinsic system (Autonomic nervous system), so ENS communicates on both sides i.e. CNS and gut functions. When a meal is in the different regions of the GI tract, sensory mechanism detect the presence of nutrients, mount physiological or pathological responses (undigested) responses in that region of the tract as well as in more distal region of the gut. These responses are mediated by neural and endocrine pathways. The neural pathway is more important because any pathological disturbances in the gut are sensed by the brain immediately and control gut functions according to the physiological response. The swallowing mechanism, gastric emptying and pancreatic secretion, all these gut functions are directly controlled by the brain, without it gut physiology is not maintained. There is considerable cross talk between gut and brain due to some hormones like (CCK, SST etc.) that are present in both part of brain and gut. The regulation of food intake is governed by hormones like Neuropeptides Y (NPY) and Ghrelin which are functional part of both the hypothalamus and the gut. The mechanism of gut is also influenced by emotions and thoughts. So the ENS is the little brain influencing the brain. The availability of functional brain imaging technique has opened up a new exciting concept and allowed to study the role of the CNS to control human gut function in health and disease. The aim of this article is to acquaint this statement by that “the gut is a Special sense organ, not just organ”.

Keywords: Brain, ENS, Special sense, NPY, Ghrelin.

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1. Introduction

Special senses are the senses which have specialized organs devoted to them. The information collected by these organs is sent to the central nervous system for further processing to produce a response. In this article we are consolidating the evidences produces by recent discoveries of 10 years to justify our statement.

Long reflexes in our body have a sensory neuron that sends information from the gut to the brain. The information generated in the gastrointestinal tract for e.g. reaction to food is signalled to the brain to produce emotions such as fear, anger and sadness. In other words we can say it as “The Gut as a mirror image of emotional facial expression” [1]

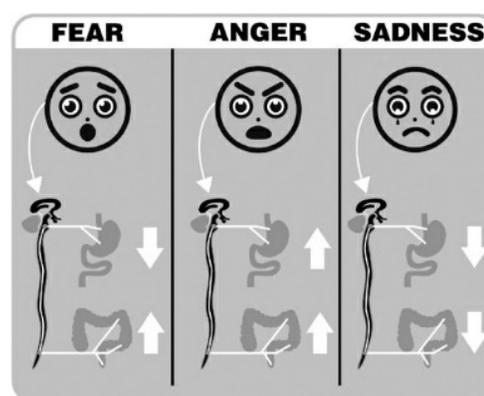


Figure 1: The Gut as a mirror image of emotional facial expression

“Gut as a mirror image of emotional facial expressions”

Signals to the upper and lower GI tract can be synchronous or go in opposite directions. Solid white arrows indicate the increase or decrease in gastrointestinal contractions associated with a particular emotion.



Figure 2: The Mind-Gut Connection

Source: Mayer, Emeran. The Mind-Gut Connection (p. 31). Harper Wave, Kindle Edition [1].

The Gut and Brain are intricately linked like a ‘ying-yang force.’(Chinese: interconnected complementary forces). This bidirectional linkage is through nerves, hormones and inflammatory molecules. Gut sensations e.g. Reaction to food are carefully adjusted by the brain to produce appropriate gut reactions e.g. Emotions

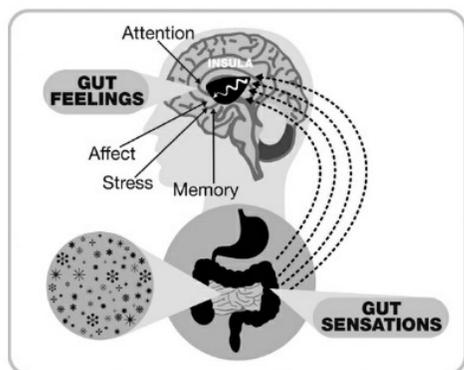


Figure 3: Figure illustrating brain constructs gut feelings from gut sensations

Source: Mayer, Emeran. The Mind-Gut Connection (pp. 13-14). Harper Wave. Kindle Edition [1].

This information in its raw format is received in the back portion of the insular cortex and then processed and integrated with many other brain systems. We only become aware of a small portion of this information in the form of gut feelings. [1]

2. Evidences

First evidence comes with the discovery of Nutrient receptors which are present on enteroendocrine cells which is inarguably our greatest endocrine organ [2,3].

The hormones discharged by these cells can even act far away to the extent of CNS.

In 2002, it was reported that taste receptors are stationed in the intestine [4]. The location of umami receptors in the stomach and intestines is confirmed by finding the effects of umami receptor stimulants [5].

The umami receptor, which is stimulated by mono sodium glutamate, is conveyed by gastric A cells and by I cells in the small intestine.

In certain plants (e.g. certain herbs and spices) peculiar odours and taste is sensed by odorant receptors present in the digestive tract [6,7]. The role of these receptors in chemosensing was unfortunately overlooked in many reviews except in 2011 by Holzer[8].

The phytochemical receptors in the gut are ligand gated ion channels known as transient receptor potential (TRP) receptors. 28 channels have been identified till dates which are grouped according to their molecular similarities into seven families [10]. TRP receptors have critical roles in sensory physiology, which include contributions to vision, taste, olfaction, hearing, touch, thermosensation and osmosensation[10]. 8 of 28 TRPs have been identified in the gut[9], but in further studies it is found that genes for all 28 are expressed in the mouse gastrointestinal mucosa (B. Callaghan, H.-J. Cho and J. B. Furness, unpublished data).

Evidence comes with the discovery of L cells which release the hormones GLP-1, GLP-2, PYY and oxyntomodulin. These hormones have actions on effectors, including enterocytes, enteric neurons, vagal sensory neurons (vagus; the effect of PYY probably being indirect) and IPANs, blood vessels, lymphocytes, myofibroblasts and the hypothalamus.

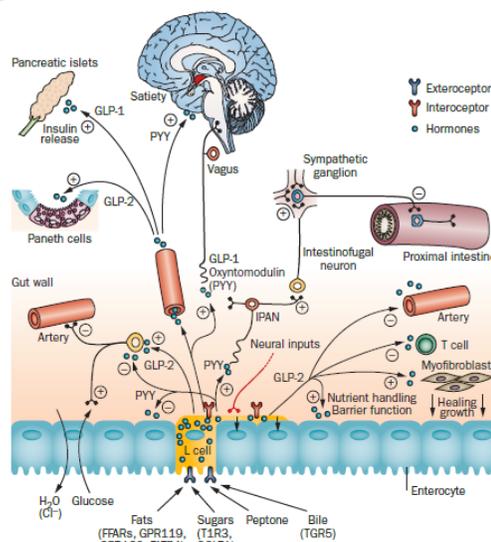


Figure 4:

Intestinfugal neurons are special type of neurons which peculiar to the gastrointestinal tract. They have cell bodies in the gut wall and send their processes to prevertebral ganglia (where they form synapses with post-ganglionic sympathetic neurons), other digestive organs and the CNS [11].

3. Conclusions

The sensing mechanism of the gut is in a close anatomical and functional relationship with brain which shows that that gut not only sense but send signal to the brain like other special sense organs. These signals are processed by brain to produce various physiological and pathological responses in a particular region of the gastrointestinal tract as well as in more distal regions which proves that Gut is a special sense organ.

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