How is food represented in the brain?

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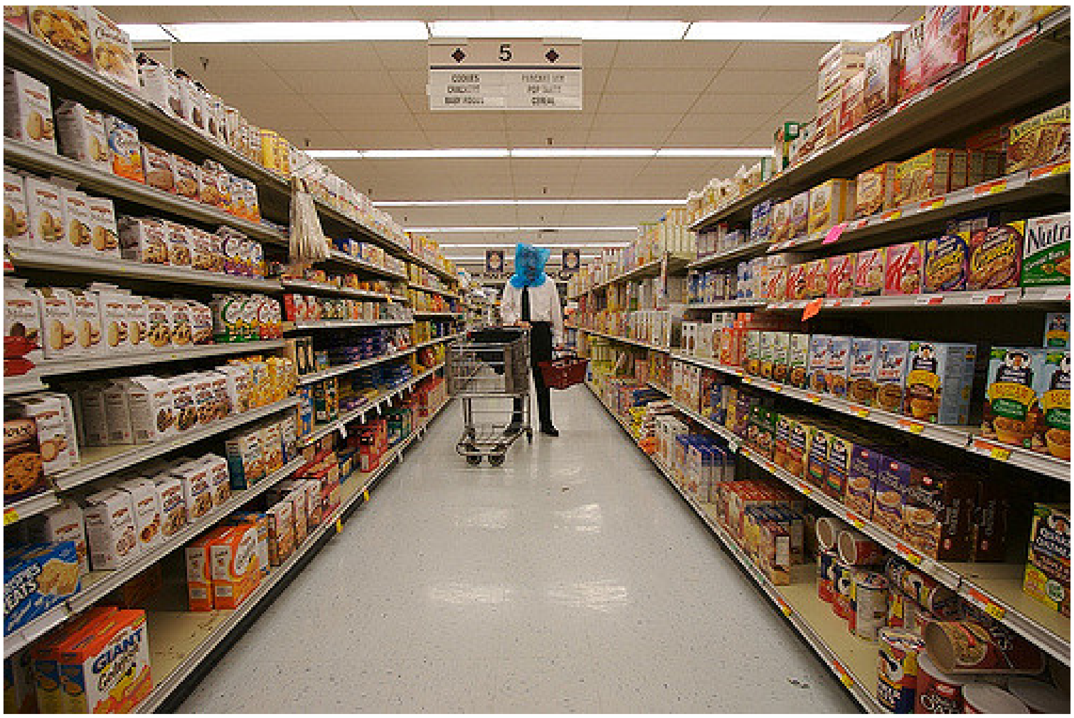

Credit: Jesse Garrison

Despite the central role of food in our lives, research has done little to discover how food concepts are organized in our brain. A review carried out at the International School for Advanced Studies (SISSA) of Trieste sorts out the knowledge gained so far, relating it to the current theories of semantic categorization. This in-depth analysis provides a useful conceptual framework for future research and for putting the different theories to the test. The paper has just been published in *Psychonomic Bulletin Review*.

It is quite surprising that, while food is so central to our lives, neuroscience has devoted limited energy to understanding how it is represented in our brain. Aware of this shortcoming, Raffaella Rumiati, professor at SISSA where she leads the INSuLa laboratory, and Francesco Foroni, SISSA research scientist, reviewed the research published to date on the topic. One of the novelties of their review is that it also considered papers dealing with brain-damaged patients. Very few studies have in fact investigated this aspect, so Rumiati and Foroni looked for those using food items as stimuli and then filtered the results through the lens of the most widely accepted theories of semantic categorization.

The first of such theories, the "sensory-functional" hypothesis, was put forward by Elizabeth Warrington, Rosaleen McCarthy and Tim Shallice in the 1980s. According to this theory, objects are divided based on the type of analysis elicited by the stimulus. In practice, this theory holds that living objects are for the most part examined in terms of their sensory features (colour, texture, taste, smell, etc.) whereas manufactured objects are analysed based on their function. This theory has interesting implications for food as it assumes that non-manufactured food (not cooked or transformed in any way) would fall into the second category (together with non-living objects) whereas "natural" food items (e.g., an apple) would be considered living objects.

A second, more recent theory ("domain-specific"), formulated by Alfonso Caramazza, holds that our semantic categorization processes have been moulded by natural selection. For this reason, we group objects into categories that are important for our survival (animals, plants, conspecifics, etc.). Unlike the sensory-functional hypothesis, this theory does not divide objects into living-nonliving categories and, with regard to food—a crucial category for survival—it assumes that relevant features may be both functional and sensory.

Rumiati and Foroni also examined the data from the standpoint of another type of semantic categorization which derives directly from embodied cognition theories. In this view, the categorization of objects is based on activation of the sensory and motor systems. An example might help to clarify the idea: Hearing the word "red" would activate the brain regions specializing in colour perception, even though the colour red has not been directly observed. Exposure to a certain object (in this case a visual object evoked through the auditory channel) activates the sensory areas even when these have not been stimulated, and this activation makes it possible to understand and recognize the object we are experiencing. Seeing a tool like a hammer, for example, will cause activation of the regions controlling the hand muscles. In this view, exposure to food stimuli will lead to activation of the areas involved in taste perception even though these have not been directly stimulated by actually putting the food in our mouths.

The review shows that the picture is still too sketchy to allow one theoretical approach to predominate over the other. "Research into the semantic categorization of food is still too sparse," explains Rumiati. "However, one important finding is that the "foodstuff" category itself can help researchers disambiguate among the various approaches even beyond this specific category: the food stimulus in fact cuts across the different domains, as it combines features of both living and non-living objects; additionally, it is fundamental for survival and is therefore of major significance in evolutionary terms."

In their review, the authors also provide a schematic outline of predictions consistent with each of the theories considered. "This way, future researchers will have a reference they can turn to when planning experiments and stimuli," adds Rumiati.

An important recommendation emerging from the review concerns experimental stimuli: more attention should be placed on the variables coming into play when a food stimulus is presented. "There are many dimensions involved: sensory features (e.g., colour), but also the level of 'transformation' of the food (is it natural or cooked?), and perceived calories (how nutritious is it?). These are all things that need to be controlled," concludes the scientist. Rumiati's group at SISSA have indeed developed a database, freely accessible to anyone, containing images of food that are standardized with respect to these variables and that may be very useful to those doing research in this field. The database is called FRIDA and can be accessed at foodcast.sissa.it.

More information: Raffaella I. Rumiati et al. We are what we eat: How food is represented in our mind/brain, *Psychonomic Bulletin & Review* (2016). DOI: 10.3758/s13423-015-0908-2

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