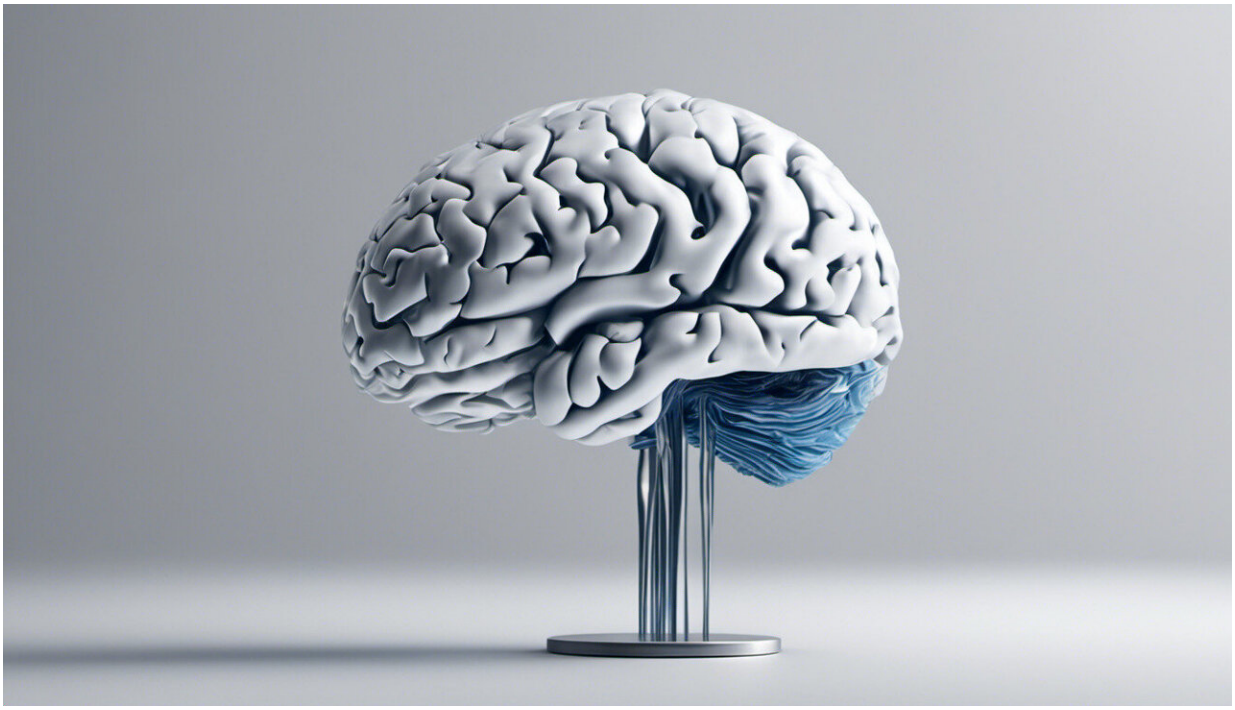
How our modular brain pieces the world together

May 24 2016, by Bronson Harry



Credit: AI-generated image (disclaimer)

Picture a close friend. Imagine their face, the sound of their voice, their height, what they normally wear. You might be surprised to learn you have just used a host of different brain regions to recall this information.

Curiously, there is no single brain region that is involved in representing

the people we know. Seeing a friend's face or hearing their voice activates different parts of the brain. This is because the brain is modular . It is made up of numerous regions that perform specific tasks.

The modular brain

The most striking example of modularity is the face perception network. Faces selectively activate a chain of distinct brain regions spanning the occipital and temporal lobes. Damage to this network profoundly impairs face recognition abilities, a condition called prosopagnosia.

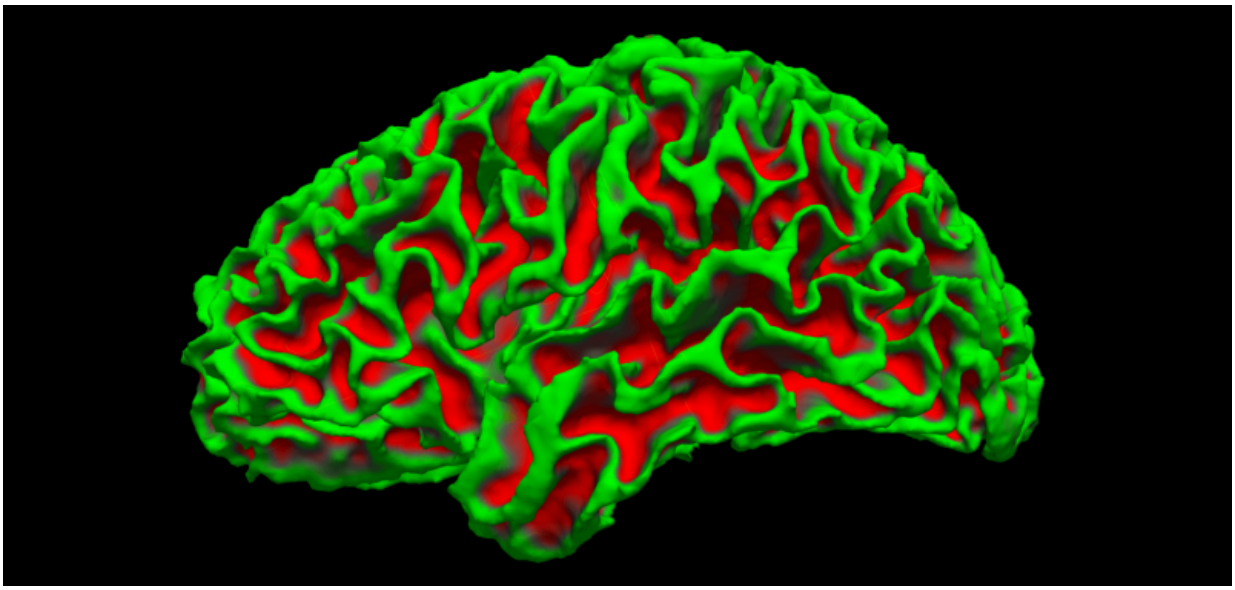
A similar network of face regions is also found in monkeys and apes suggesting that a modular face network is an evolutionary adaptation. Possessing dedicated face processing hardware likely allowed us to quickly discern friend from foe, and such rapid identification would undeniably have helped our ancestors cope with the pressures of living in social groups.

Although important, faces are not the only source of information we use to identify people. It is possible to recognise someone simply by hearing their voice. Indeed, patients with damage to their face processing network can still recognise people from the sound of their voice or the way they dress.

However, there is no single brain network involved in analysing identity. Voices are processed by an area located in the auditory cortex, and body areas are anatomically distinct from regions that process faces. So how does the brain combine these different physical cues to generate the sense of a unique individual?

Putting it all together

Consider a comedian imitating a politician. Comedians can evoke a strong sense of another person's identity, even when they lack a clear physical resemblance to the person being imitated. Likewise, actors can create a diverse range of characters simply by changing their voice, posture and how they move.



Surface model of the author's brain. Author provided

If the regions that process faces, bodies and voices are anatomically distinct, then how is our unified sense of another person's identity formed? How do these different networks communicate with each other?

We recently explored this question in a brain imaging study that examined the spatial organisation of face and body networks. We used magnetic resonance imaging (MRI) to record brain activity while participants viewed images of faces, bodies and common household

objects. We examined brain responses in two face areas, one in a region associated with memory and another in a region involved in vision.

In the visual region, responses to faces and bodies showed a modular organisation. We found that face and body selective areas were spatially distinct from each other. However, in the memory region, face and body selective responses were similarly organised, so areas that preferred faces also showed a preference for bodies.

A group of MIT researchers who examined the brains of monkeys found similar results. In this study, monkeys were shown pictures of faces, headless bodies and images of whole bodies with the faces intact.

The results showed that the face area in the same memory region preferred images of whole bodies compared to either faces or bodies alone. Importantly, the response to whole bodies was greater than the combined response to isolated faces and bodies.

The binding power of memory

Together, these studies show that information from the face and body networks converge in parts of the brain that form memories. Previously, it was understood that these memory regions were associated with knowing whether a face was familiar.

This new evidence tells us that memory regions are also responsible for binding together different perceptual cues to create holistic, integrated representations of the people we encounter.

These findings illustrate how the brain uses different organisational schemes to help us understand our social world. A modular organisation affords fast, efficient extraction of important information about the people around us.

However, the brain must also bind the output from these various systems together to keep track of all the different people we interact with. Doing so helps us organise the complex web of friends, family, colleagues, Facebook acquaintances, public figures and celebrities that populate our increasingly social world.

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