Embodiment

Mary ET Boyle, Ph.D.
Department of Cognitive Science
UCSD

Erik Swanson
The Body Has a Mind of Its Own

How Body Maps in Your Brain Help You Do (Almost) Everything Better

Sandra Blakeslee and Matthew Blakeslee

Phantoms in the Brain

V.S. Ramachandran, M.D., Ph.D., and Sandra Blakeslee

Foreword by Oliver Sacks, M.D.

Probing the Mysteries of the Human Mind

"Enthralling."
—The New York Times Book Review
The body mandala
Mind – Body
Rene Descartes

- Reflex arc
- Physical vs. Mental
- Understanding both domains
- Interaction between both?
peripersonal space- like an aura

Your brain annexes the space around your body
• Your self does not end where your flesh ends

Your body map will blend with the horses body map.

Using tools...
• The bat has been incorporated into your body map.
Elbow Room

Tribe in Namibia
Intermingle with others
Born with self-space
Never alone!

Himba Tribe woman
lonelyplanetimages.com
Does your hand belong to you?

• How do you know it’s your own hand?
• How do you know that you have a body?

• What makes you think you own it?

• How do you know where your body begins and ends?
• How do you keep track of its position in space?
In the 19th century, German physician *Franz Joseph Gall* divided the brain into dozens of personality organs to which the skull was said to conform.
Brain is a bordered organ – subdivided into zones and functions.

Specialized neurons?

Lines are blurry

Memories and emotions?
Dr. Wilder Penfield
electrical stimulation mapping
Out-of-body experiences: from Penfield to present

Frank Tong

Department of Psychology, Princeton University, Princeton, NJ 08544, USA

Can the brain, when stimulated, yield entirely novel experiences? Blanke et al. (2002) describe a patient who reported spontaneous out-of-body experiences during electrical stimulation of her angular gyrus. These findings, although apparently extraordinary, agree with much earlier reports from a patient tested by Wilder Penfield. Such studies can provide clues about the nature of conscious experience.

Blanke et al. recently described a preoperative epilepsy patient who reported spontaneous out-of-body experiences during electrical stimulation of her right angular gyrus [1]. This study is both interesting and important because it addresses the problem of whether brain activity induced by local stimulation can elicit familiar experiences only, novel combinations of familiar experiences, or experiences that are entirely novel.

The 43-year-old woman in the study suffered complex partial seizures and had temporarily implanted subdural electrodes to identify the epileptic focus. Stimulation at two specific electrode sites over the angular gyrus at the parietal-temporal junction elicited novel vestibular illusions of falling or floating (Fig. 1a). Initial stimulation led to sensations of ‘falling from a height’ or ‘sinking into the bed’. Higher amplitude stimulation led to the report of an apparent out-of-body experience. She reported that ‘I see myself lying in bed, from above, but I only see my legs and lower trunk’. In actuality, the patient was lying in bed with her upper body supported at a 45-degree incline. It is worth noting that despite the patient’s shift in perceived vantage point, her description of the items in view remained veridical – that is, she did not report seeing her entire body and face from above. Subsequent stimulation led to vestibular illusions of lightness and floating above the bed close to the ceiling. Moreover, when the patient was instructed to watch her legs, stimulation of the same site led to the patient to report that her legs had become shorter or that they appeared to be moving towards her face. Similar effects occurred when she attended to her arms.

The findings suggest that distortion of vestibular and somatosensory processing in the angular gyrus can lead to out-of-body experiences. However, given the extraordinary nature of these reported experiences and possible variability in cortical organization among epileptic patients, one might wonder how to consider such a single, albeit remarkable, clinical report.

Pioneering investigations of electrical brain stimulation

Wilder Penfield, a pioneer at investigating the effects of electrical stimulation in conscious humans under local
Stimulation at other sites elicited other behavioral responses: magenta, motor responses; green, somatosensory; blue, auditory. Stars indicate the epileptic focus in the medial temporal lobe.
In 1941 Penfield reported a similar situation. Patient G.A. suffered habitual epileptic attacks that never evoked hallucinations. Yet upon electrical stimulation of her right superior temporal gyrus at point 0 she spontaneously exclaimed: ‘I have a queer sensation as if I am not here... As though I were half here and half not here.’ She reported that she had never felt this way before. Stimulation of point 1 elicited the response that she felt queer again, as if she were floating away. Similar responses occurred for point 3 and for point 5 in the neighboring parietal lobe.
OBE – could be a failure to integrate somatosensory and vestibular information

The specific area involved in OBE is the temporoparietal junction (TPJ) on the right side. “Neural correlate of disembodiment!”
Stimulating illusory own-body perceptions

The part of the brain that can induce out-of-body experiences has been located.

"Out-of-body" experiences (OBEs) are curious, usually brief sensations in which a person's consciousness seems to become detached from the body and take up a remote viewing position. Here we describe the repeated induction of this experience by focal electrical stimulation of the brain's right angular gyrus in a patient who was undergoing evaluation for epilepsy treatment. Stimulation at this site also elicited illusory transformations of the patient's arm and legs (complex somatosensory responses) and whole-body displacements (vestibular responses), indicating that out-of-body experiences may reflect a failure by the brain to integrate complex somatosensory and vestibular information.

Our patient was a 43-year-old, right-handed woman who had suffered from complex partial seizures for 11 years; right temporal-lobe epilepsy was implicated. As magnetic-resonance imaging did not reveal any lesion, invasive monitoring was undertaken to localize the seizure focus precisely.

Blanke, et al. NATURE | VOL 419 | 19 SEPTEMBER 2002
Immediate Interpersonal and Intermanual Referral of Sensations Following Anesthetic Block of One Arm

Laura K. Case, MA; Reid A. Abrams, MD; Vilayanur S. Ramachandran, MD, PhD

**Objectives:** To explore whether interpersonal and intermanual sensory referral occurs following anesthetic block of a limb and to test theories of disinhibition of mirror neuron activity and transcallosal referral.

**Design:** Case series.

**Setting:** Outpatient surgery at the University of California San Diego Medical Center.

**Patients:** Six patients who underwent orthopedic surgery.

**Main Outcome Measures:** Patient verbal ratings.

**Results:** Patients with brachial plexus blocks experienced touch sensations in the anesthetized arm when watching another person’s arm being touched or when the contralateral intact hand was touched.

**Conclusions:** To our knowledge, this is the first demonstration of rapid reorganization of functional connectivity in the adult human brain, most likely in S2 neurons. This finding suggests that conscious perception of touch results from fluctuating mosaics of cortical excitation and inhibition between different regions within the patient’s own S2 neurons and, more remarkably, from viewing others’ sensations.

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The senses

- sight
- taste
- hearing
- smell

somatic
Nocioception
Proprioception
Balance
Thermoception
Touch
Touch receptors send your brain information about pressure.

For example: gentle pressure, deep pressure, sustained pressure, hair follicle bending, and vibration.

In one’s daily life, touch is by far the most prominent of the somatic senses in your conscious mind.
Thermoception

When you feel the sun beating down on you.

Skin thermoceptors: warm and cold

When you swish an ice cube in your mouth.

Not for body temp regulation
Nociception

Piercing pain

Chemical pain

Heat pain

Joint pain

Tickle

Deep tissue pain

Itch
Proprioception

Inherent sense of your body’s position and motion in space

Enables one to touch your index fingers with your eyes closed

Two types:

- Embedded in cartilage between skeletal joints and keeps track of load and rate of slippage in each joint.
- Embedded in muscles and tendons and measures stretch
Sense of up vs. down

Inner ear canals

Needed to operate body in the world

Evolved early – half billion years ago
Sensory information

Pain and touch

Complex, composite sensations

Wetness
Hairiness
Fleshiness
Rubberiness
From 1998 BBC documentary "The Man Who Lost His Body."