“Your body is not just a vehicle for your brain to cruise around in. The relationship is perfectly reciprocal: Your body and your brain exist for each other. … Meaning is rooted in agency (the ability to act and choose), and agency depends on embodiment.”

Sandra Blakeslee and Matthew Blakeslee – The Body Has a Mind of It’s Own
MOVEMENT-PRODUCED STIMULATION IN THE DEVELOPMENT OF VISUALLY GUIDED BEHAVIOR

Journal of Comparative and Physiological Psychology 1963, Vol. 56, No. 5, 872-876
human brain holds and continuously updates an internal map of the body

Using tendon vibration distort volunteers’ brains rapidly adjusted the processing of touch information to match information from proprioception – the position to the limbs relative to the body.
Blindfolded subjects held their left index finger with their right arm.

Vibration was applied to the right arm on the biceps tendon.

..... a subjective elongation of the left index finger.

The triceps vibration induced a subjective flexion of the right arm and, consequently, a subjective shrinking of the left index.
The case of Tom and Philip...
Phantom Limb – From
https://www.youtube.com/watch?v=1mHIv5ToMTM
There is a secondary somatosensory cortex (region S2) (Brodmann Areas 40 and 43).

Area is responsive to light touch, pain, visceral sensation and tactile attention. Very large receptive areas.
Insula and Amygdala

Both are involved in the mediation of emotion and emotional states.

Profile of the Anterior Insula
The anterior insula is implicated in reactions of disgust and has been shown to support general bodily awareness. The region senses our visceral states, which form the basis of gut feelings that inform decision making. Previous research has also shown that neural activation in the anterior insula is important for assessing risks, responding to breaches in trust, representing expected financial risks and predicting the safety of choice outcomes, according to the PNAS paper. —M.W.M.
intraparietal sulcus (IPS)

- Perceptual-motor coordination (for directing eye movements and reaching) and visual attention
- Processing symbolic numerical information
- Visuospatial working memory
- Interpreting the intent of others
Fig 2. Confluences between tactile sensitivity way and nociceptive way.
LEFT PARIETAL OPERCULUM

LEFT PARIETAL LOBE
(the boundaries are arbitrary)

left central sulcus
left postcentral sulcus
left supramarginal gyrus
left inferior parietal lobule

left sylvian fissure
GSR and its Mediators

electrical conductance of skin
sympathetic nervous system
insula mediates
amygdala influences
Apotemnophilia, a disorder that blurs the distinction between neurology and psychiatry, is characterized by the intense and longstanding desire for amputation of a specific limb. Here we present evidence from two individuals suggestive that this condition, long thought to be entirely psychological in origin, actually has a neurological basis. We found heightened skin conductance response to pinprick below the desired line of amputation. We propose apotemnophilia arises from congenital dysfunction of the right superior parietal lobule and its connection with the insula.
B.C. was a 63-year-old right-handed man who reported that since the age of 4 years he had desired bilateral lower limb amputations. Specifically, he indicated that he wanted his *right leg* to be amputated four inches below his *hip* joint and his *left leg* to be amputated two inches below the *knee*, and he stated that these parts felt as if they were ‘just not’ his. He attributed his feelings about his legs to ‘a possessive mother’, ‘an abusive boss’ and a desire to ‘fit in’. He noted that *recently the left-side desire had become particularly strong, while conversely his desire for a right-sided amputation had decreased*. He contacted us a year later to report that the desire for an amputation on his right side had almost completely disappeared. Several months after this, *He had an elective left below-knee amputation* and subsequently stated that he no longer had any desire for a *right leg amputation*.

B.C. 63 y/o man – desires both legs amputated; left leg below the knee; right leg below the thigh.
Changes in skin conductance recording in response to pinprick above and below desired levels of amputation in the legs. B.C. wanted both legs amputated. Individuals with apotemnophilia show significant increases SCR below the level of amputation.
Body map integration failure

“They can feel the body being touched, but it does not integrate into their sense of body image…They know the limb is part of their body, but it's 'more' than it should be. It should be gone.”

Paul McGeoch, UCSD
A.O. was a 29-year-old right-handed man who desired a right mid-tibial amputation. He recalled that a ‘strong desire’ for the amputation of his right leg around the middle of his tibia started around the age of 12 years and had been constant since then. He denied a sexual motivation, but stated that rather the presence of his right leg made him feel ‘over-complete’ and that he simply wanted it ‘gone’. He had cut off the distal phalanx of his right middle finger after reading on the internet that this might alleviate his desire for amputation of his leg. He had no a priori desire to amputate this phalanx and its removal did not have an impact on the strength of his desire for his leg to be amputated. He readily acknowledged that his feelings about his leg were not normal. On neurological examination, he reported that pinprick was, possibly, slightly duller in a stocking distribution from the mid-level of his right tibia down. He also commented that at other times the same area felt ‘more sensitive’ than the other side. A month after visiting us, he irrevocably damaged his right leg with dry ice, thus necessitating a right below-knee amputation.

Magnetoencephalography

- MEG
- measures changes in magnetic fields that are correlated to neuronal firing.
Where is the brain malfunction?

Right superior parietal lobule (rSPL)
Linked to people’s representation of their own body

Tap foot to see which areas of the brain are responsive.
Use MEG to visualize neuronal activity.

Touch the normal limb → right parietal lobe showed activity;

Touch the limb they want amputated → no right parietal lobe activity.
Site of desired amputation and right SPL activation detected by MEG in response to tapping of the feet.

Data from:
Apotemnophilia – the Neurological Basis of a ‘Psychological’ Disorder.

McGeoch, Paul, Brang, David, Song, Tao, Lee, Roland, Huang, Mingxiong, and Ramachandran, Vilayanur.

Available from Nature Precedings (2009)
http://hdl.handle.net/10101/npre.2009.2954.1

sPL Activation in BIID Case

Control

Patient
Body Integrity Identity Disorder (BIID)—Is the Amputation of Healthy Limbs Ethically Justified?

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The term body integrity identity disorder (BIID) describes the extremely rare phenomenon of persons who desire the amputation of one or more healthy limbs or who desire a paralysis. Some of these persons mutilate themselves; others ask surgeons for an amputation or for the transection of their spinal cord. Psychologists and physicians explain this phenomenon in quite different ways; but a successful psychotherapeutic or pharmaceutical therapy is not known. Lobbies of persons suffering from BIID explain the desire for amputation in analogy to the desire of transsexuals for surgical sex reassignment. Medical ethicists discuss the controversy about elective amputations of healthy limbs: on the one hand the principle of autonomy is used to deduce the right for body modifications; on the other hand the autonomy of BIID patients is doubted. Neurological results suggest that BIID is a brain disorder producing a disruption of the body image, for which parallels for stroke patients are known. If BIID were a neuropsychological disturbance, which includes missing insight into the illness and a specific lack of autonomy, then amputations would be contraindicated and must be evaluated as bodily injuries of mentally disordered patients. Instead of only curing the symptom, a causal therapy should be developed to integrate the alien limb into the body image.

Keywords: autonomy, body scheme disturbance, body integrity identity disorder, elective amputations
Desire for amputation of a limb: paraphilia, psychosis, or a new type of identity disorder

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First, M. B. Psychological Medicine, 2004, 34, 1–10
Method. Structured interviews were conducted by telephone of 52 subjects (mean age: 48.6, range 23–77 years; 47 male, 4 female, 1 intersexed) self-identified as having had a desire to have an amputation.

Results. Seventeen per cent \((n=9)\) had an arm or leg amputated with two-thirds using methods that put the subject at risk of death and one-third enlisting a surgeon to amputate their healthy limb. The most common reported reason for wanting an amputation was the subject’s feeling that it would correct a mismatch between the person’s anatomy and sense of his or her ‘true’ self (identity). None were delusional. For all but one subject age at onset was during childhood or early adolescence. For those who had psychotherapy or medication there was no change in the intensity of the desire for amputation. The six subjects who had an amputation at their desired site reported that following the amputation they felt better than they ever had and no longer had a desire for an amputation.

Conclusions. These preliminary results suggest the existence of an extremely unusual clinically distinct condition characterized by a lifelong desire to have an amputation of a particular limb. The condition is associated with serious negative consequences: amputation attempts, impairment and marked distress. Reflecting similarities between Gender Identity Disorder and this condition, the author suggests that it may be conceptualized as an unusual dysfunction in the development one’s fundamental sense of anatomical (body) identity.
Anatomical Identity Crisis

Amputation to establish their “true identity”

“I felt like I was in the wrong body—that I am only complete with both my arm and leg off on the right side”

Is BIID similar to gender identity disorder?

First, M. B. Psychological Medicine, 2004, 34, 1-10
Does psychotherapy work?

Treatment efficacy

A majority of the subjects (65%, \( n = 34 \)) had been in psychotherapy at some time in their lives but remarkably, almost half (\( n = 16 \)) never told their therapists about their desire for amputation, fearing that the therapist would consider this evidence of severe mental illness. For none of the subjects did psychotherapy reduce the intensity of the desire for amputation. Forty per cent (\( n = 21 \)) of the subjects...
What about SSRIs?

had taken psychotropic medication at some point in their lives (usually for depression), with 16 out of 21 a selective serotonin re-uptake inhibitor (SSRI) or clomipramine (although most were unable to recall prescribed doses). None of these subjects reported any appreciable effect from the medication on the desire for amputation (although mood often improved).
Are we really sure
–which came first?

Desire could change circuitry.

Circuitry could create desire.
Anorexia Nervosa

misperception of true body size

extreme control of food intake
In an experiment, blindfolded healthy women and patients with anorexia nervosa felt designs in sunken relief (top) and then drew them on paper (tables). The patients had difficulty making accurate drawings, suggesting a deficit in the operation of sense of touch. Brain activity measurements taken while the patients felt the reliefs showed less activity in the right parietal cortex (at right). The author hypothesizes that flaws in tactile capabilities and in the integrative function of the parietal cortex could contribute to faulty body image in anorexics.

Grunwald, M
Scientific American Mind 2004
Regional cerebral blood flow changes in early-onset anorexia nervosa before and after weight gain

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The role of the right parietal lobe in anorexia nervosa.

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Abstract

BACKGROUND: Patients with anorexia nervosa (AN) overestimate their size despite being severely underweight. Whether this misperception echoes an underlying emotional disturbance or also reflects a genuine body-representation deficit is debatable. Current measures inquire directly about subjective perception of body image, thus distinguishing poorly between top-down effects of emotions/attitudes towards the body and disturbances due to proprioceptive disorders/distorted body schema. Disorders of body representation also emerge following damage to the right parietal lobe. The possibility that parietal dysfunction might contribute to AN is suspected, based on the demonstrated association of spatial impairments, comparable to those found after parietal lesion, with this syndrome.

METHOD: We used a behavioral task to compare body knowledge in severe anorexics (n=8), healthy volunteers (n=11) and stroke patients with focal damage to the left/right parietal lobe (n=4). We applied a psychophysical procedure based on the perception, in the dark, of an approaching visual stimulus that was turned off before reaching the observer. Participants had to predict whether the stimulus would have hit/missed their body, had it continued its linear motion.

RESULTS: Healthy volunteers and left parietal patients estimated body boundaries very close to the real ones. Conversely, anorexics and right parietal patients underestimated eccentricity of their left body boundary.

CONCLUSIONS: These findings are in line with the role the parietal cortex plays in developing and maintaining body representation, and support the possibility for a neuropsychological component in the pathogenesis of anorexia, offering alternative approaches to treatment of the disorder.
Overestimated Boundaries

both right parietal lesion patients and anorexia patients overestimated their body boundary
Diminished size–weight illusion in anorexia nervosa: evidence for visuo-proprioceptive integration deficit

Laura K. Case · Rachel C. Wilson · Vilayanur S. Ramachandran

Striking parallels between body size overestimation in anorexia and body image distortion in patients with right superior parietal lobule (rSPL) damage have been noted by a number of authors (e.g. Tomasino 1996). The rSPL is associated with multisensory construction of body image. Damage to the right parietal lobule can cause unilateral neglect, denial of paralysis (anosognosia), or misattribution of a paralyzed limb to another person (somatoparaphrenia; Critchley 1953). Right parietal dysfunction has also been associated with hatred of the left side of the body and with the desire to amputate a healthy limb that inexplicably feels over-present or unnatural (McGeoch et al. 2011). Individuals with anorexia similarly exhibit body image distortion and denial about the state of their body.
New insights into symptoms and neurocircuit function of anorexia nervosa

Walter H. Kaye*, Julie L. Fudge† and Martin Paulus§

Abstract | Individuals with anorexia nervosa have a relentless preoccupation with dieting and weight loss that results in severe emaciation and sometimes death. It is controversial whether such symptoms are secondary to psychosocial influences, are a consequence of obsessions and anxiety or reflect a primary disturbance of brain appetitive circuits. New brain imaging technology provides insights into ventral and dorsal neural circuit dysfunction — perhaps related to altered serotonin and dopamine metabolism — that contributes to the puzzling symptoms found in people with eating disorders. For example, altered insula activity could explain interoceptive dysfunction, and altered striatal activity might shed light on altered reward modulation in people with anorexia nervosa.
Box 1 | DSM-IV, diagnostic criteria for anorexia nervosa

- Refusal to maintain body weight at or above a minimally normal weight for age and height (for example, weight loss leading to maintenance of body weight less than 85% of that expected; or failure to make expected weight gain during period of growth, leading to body weight less than 85% of that expected).

- Intense fear of gaining weight or becoming fat, even though underweight.

- Disturbance in the way in which one’s body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight.

- In postmenarcheal females, amenorrhea (that is, the absence of at least three consecutive menstrual cycles).

- There are two types of anorexia nervosa: 1. Restricting type, in which the person has not regularly engaged in binge-eating or purging behaviour; 2. Binge-eating/purging type, in which the person has regularly engaged in binge-eating or purging behaviour (that is, self-induced vomiting or the misuse of laxatives, diuretics or enemas).
Body Dysmorphic Disorder

perceived flaw

obsession to the point of inability to function properly in the world
Body dysmorphic disorder (BDD) is an intriguing and relatively common somatoform disorder that has been described around the world for more than a century (Phillips 1991). BDD often causes severe distress and notably impaired functioning, and it can lead to suicide. However, this disorder is typically underrecognized in clinical settings.

BDD is defined in DSM-IV as a preoccupation with an imagined defect in appearance; if a slight physical anomaly is present, the person’s concern is markedly excessive (American Psychiatric Association 1994). The preoccupation causes clinically significant distress or impairment in social, occupational, or other important areas of functioning, and it cannot be better accounted for by another mental disorder, such as anorexia nervosa. Although BDD is classified as a somatoform disorder, its delusional variant is classified as a psychotic disorder (a type of delusional disorder, somatic type).
Patients with BDD typically think about their perceived flaws for 3–8 hours a day (Phillips 1996a). As Ladee (1966, p. 324) wrote: “The preoccupation is so exclusively centered on one aspect of the bodily appearance, which is experienced as deformed, repulsive, unacceptable, or ridiculous, that the whole of one’s existence is dominated by this preoccupation and nothing else has any significance any more.” The thoughts are usually difficult to resist or control and are very distressing, as noted by Morselli (1891), who pointed out that “the dysmorphophobic patient is really miserable.” Such patients have low self-esteem (Rosen and Ramirez 1998) and are rejection sensitive (Phillips et al. 1996a).
Gender Similarities and Differences

Two studies that examined gender-related aspects of BDD found that the clinical features of the disorder appear to be similar in men and women. One of these studies (\(N = 188\)) found, however, that women were more likely than men to focus on their hips and weight, camouflage with makeup and pick their skin, and have comorbid bulimia nervosa (Phillips and Diaz 1997). In addition, the study found that men were more likely to be unmarried; be preoccupied with body build, genitals, and hair thinning; use a hat for camouflage; and have alcohol abuse or dependence. In the other study (\(N = 58\)), women were more likely to focus on their breasts and legs, check mirrors and camouflage, and have bulimia, panic disorder, and generalized anxiety disorder; men were more likely to focus on their genitals, height, and excessive body hair, and have bipolar disorder (Perugi et al. 1997a).
Cross-Cultural Aspects

Case reports and series from around the world suggest that the clinical features of BDD are similar across cultures, with culture producing nuances on a basically invariant, or universal, expression of BDD (Phillips 1996a).

Koro, a culture-related syndrome that may be related to BDD, occurs primarily in Southeast Asia. It is characterized by a preoccupation that the penis (labia, nipples, or breasts in women) is shrinking or retracting and will disappear into the abdomen, resulting in death (Chowdhury 1996). Although koro has similarities to BDD, it differs from BDD by its usually brief duration, different associated features (e.g., fear of death), response to reassurance, and occasional occurrence as an epidemic.
Summary

The function of the right parietal lobe in body image disorders

The possible correlation of other disorders with right parietal damage cases

What can happen when these areas are damaged by head trauma or stroke

Brain lesion studies provide evidence of brain regions that help mediate body representations
The Future of these Studies

Look at attention confounds

The better we understand these disorders, the better we can provide treatment for those afflicted

Create studies with more controls

Treatments exist for the reintegration of body image in anorexic patients

Create more behavioral tasks
Review Anatomy:

- motor cortex
- somatosensory cortex
- sup. parietal lobule
- auditory cortex
- visual cortex
Citations


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