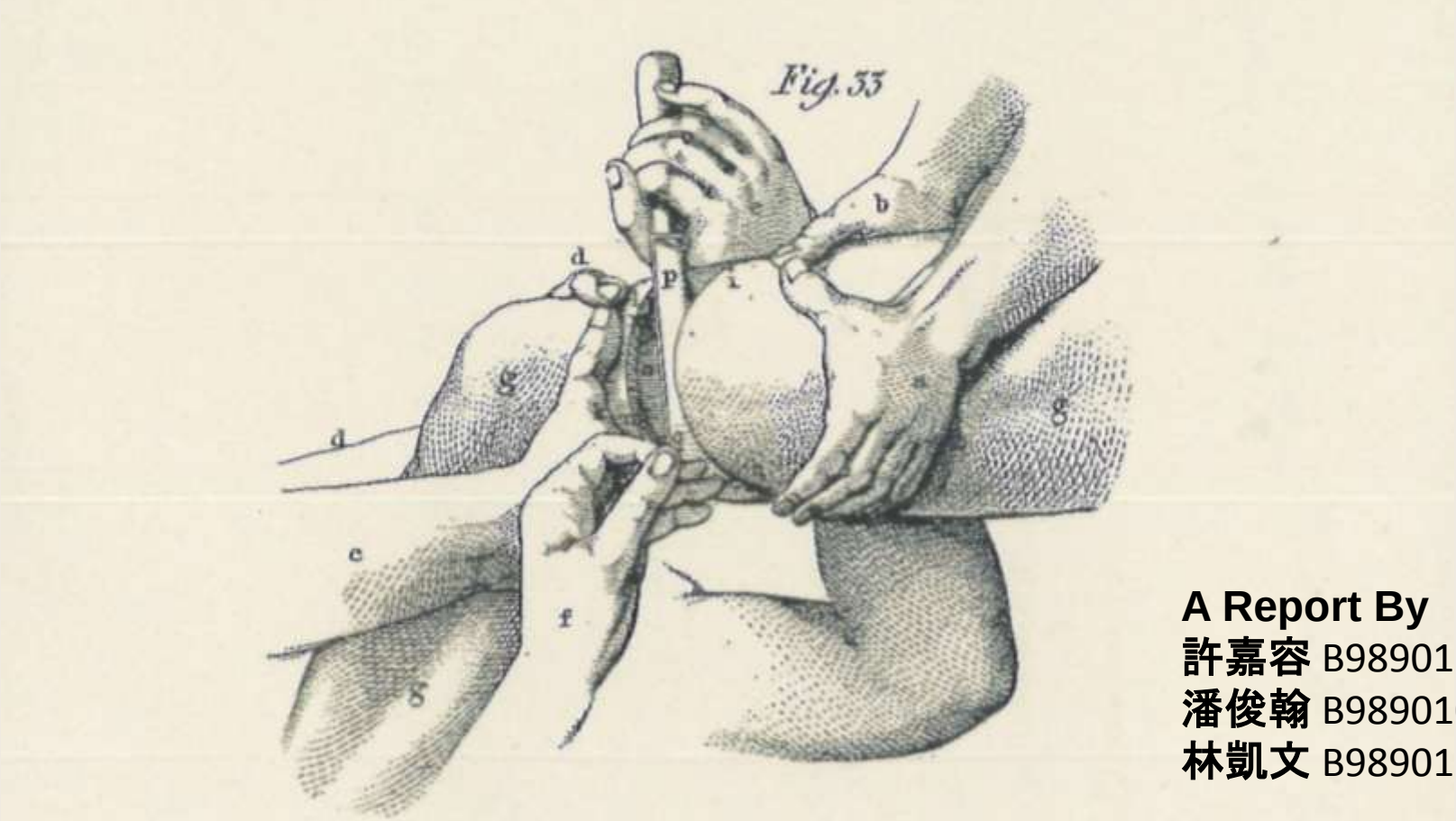
PHANTOM LIMB SYNDROM

- How Prosthetics Can Treat This Agony



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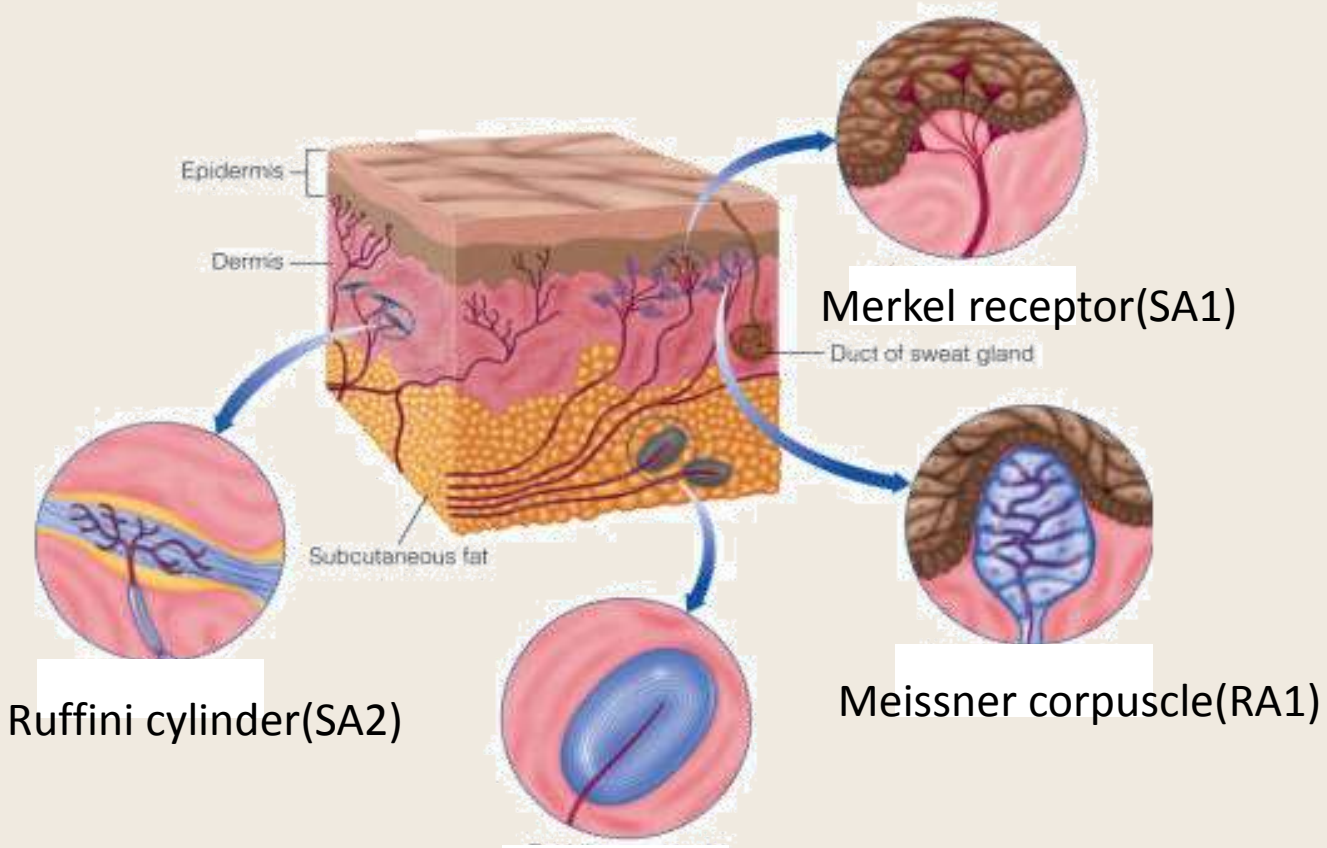
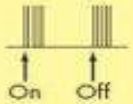
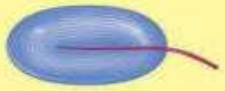
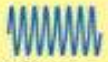
Sense of Touch

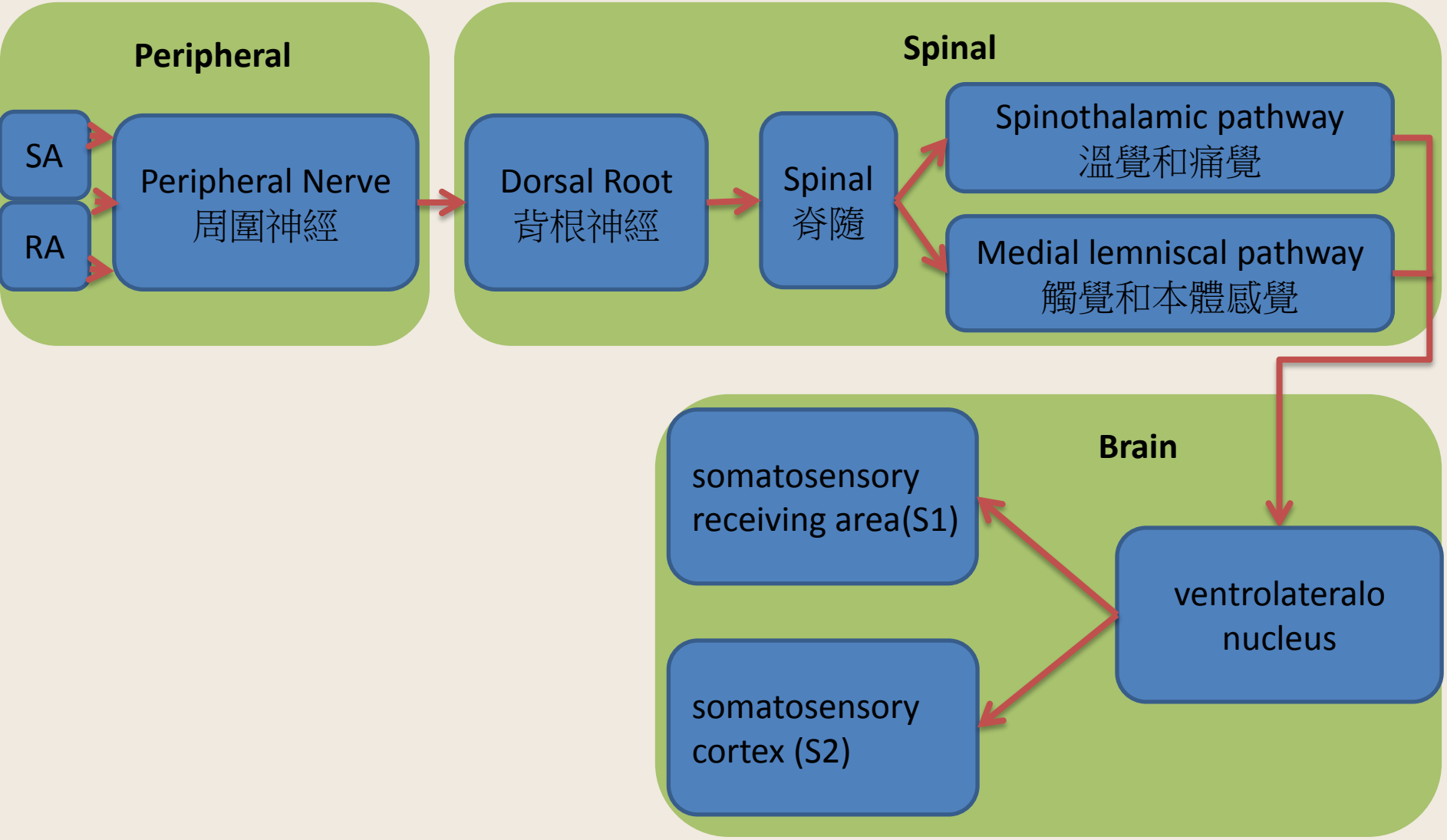


Category of Receptor

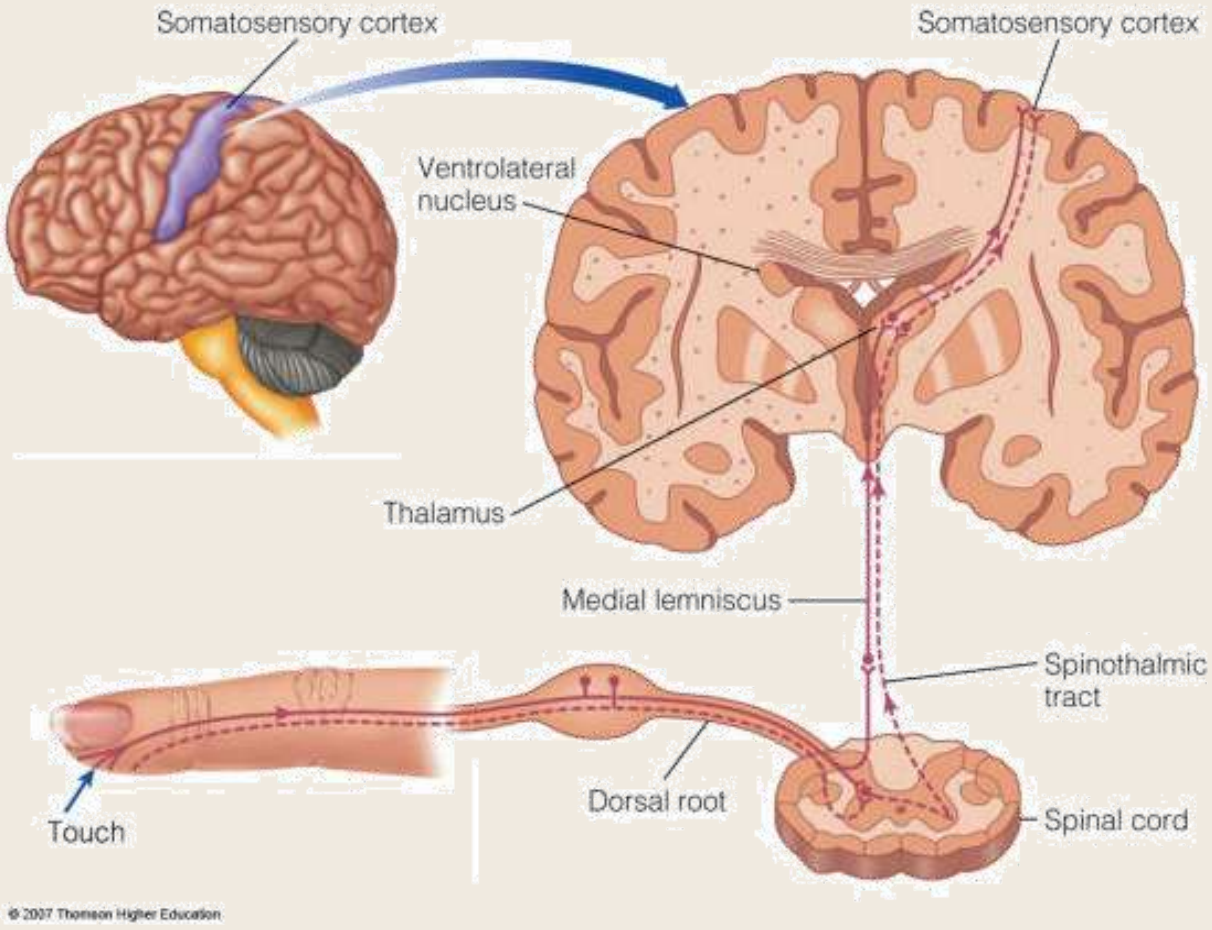
Table 14.1 *Properties of Four Types of Mechanoreceptors*

Receptor (Fiber)	How Fiber Responds	Frequency Response	Perceptions
 Merkel (SA1)	 Continuous (slow adapting)	0.3–3 Hz Slow pushing	 Fine details
 Meissner (RA1)	 On Off Responds to change (rapid adapting)	3–40 Hz	 "Flutter" Hand-grip control (tools)
 Ruffini (SA2)	 Continuous (slow adapting)	15–400 Hz	 Stretching
 Pacinian (RA2)	 Responds to change (rapid adapting)	10–500 Hz Rapid vibration at upper range	 Vibration  Texture by moving fingers

Flow Chart of The Pathway



Pathway of The Signal

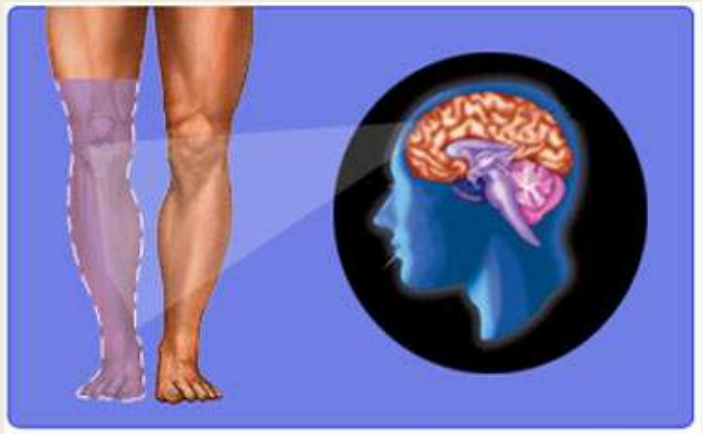


What is Phantom Limb ?

•A complex phenomenon involving a sensation that an amputated or a missing limb is still attached to the body.

•Approximately **60 to 80 %** of individuals who have undergone amputations have reported this sensation.

Also has been observed in those **who are born without limbs and in those who are paralyzed.**



Source: MedIndia.net

Irritation caused at the nerve endings : **neuromas**

It was once believed that these nerve endings send the **wrong** signal to the brain, which is interpreted as pain

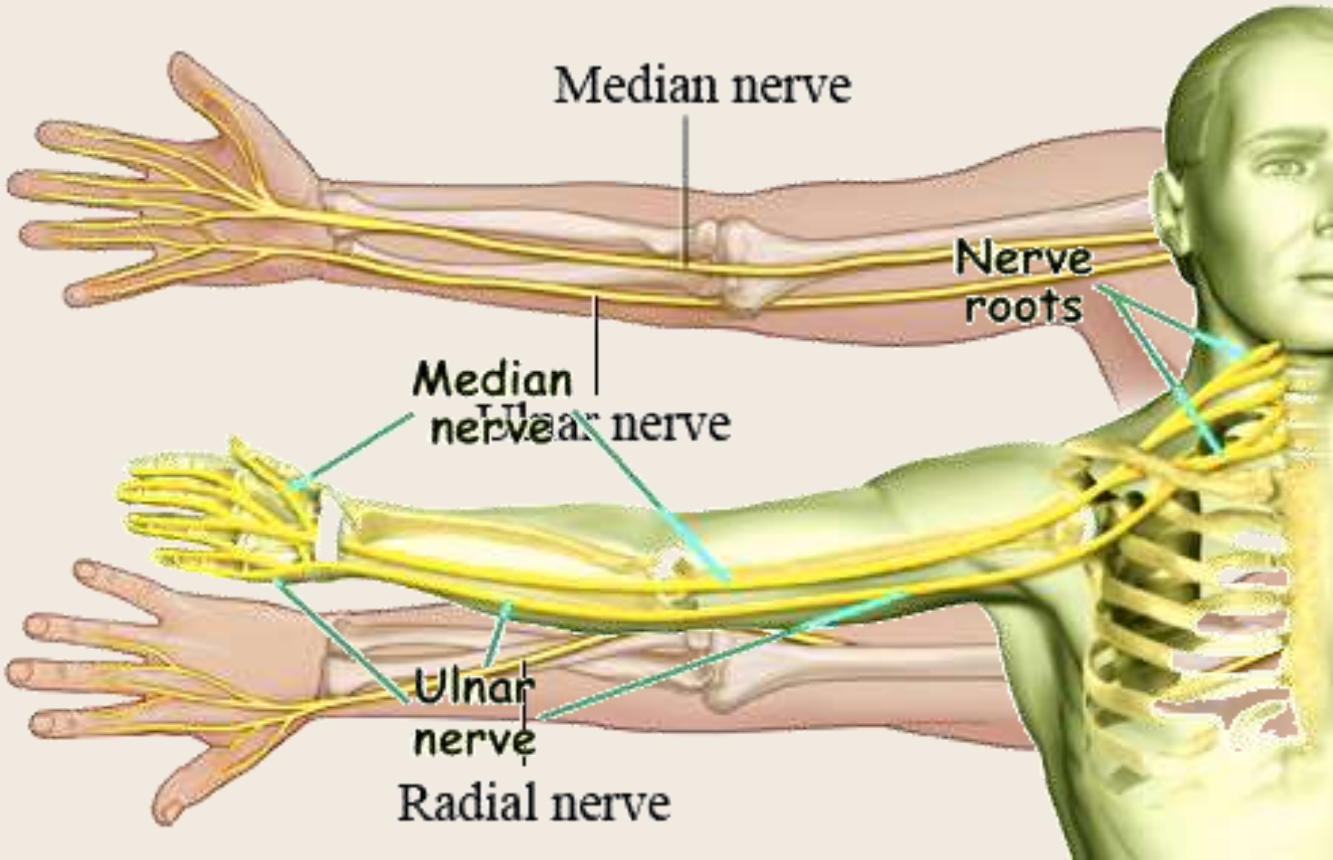
In some cases, when the pain was too severe, the surgeon would perform **a second amputation** to further remove the end of the amputated limb, in order to provide temporary relief to the patient

•However, in many, the pain increased after the second surgery and the **phantom sensation doubled**

Treatment based on this was not successful

傷害感受 Nociception

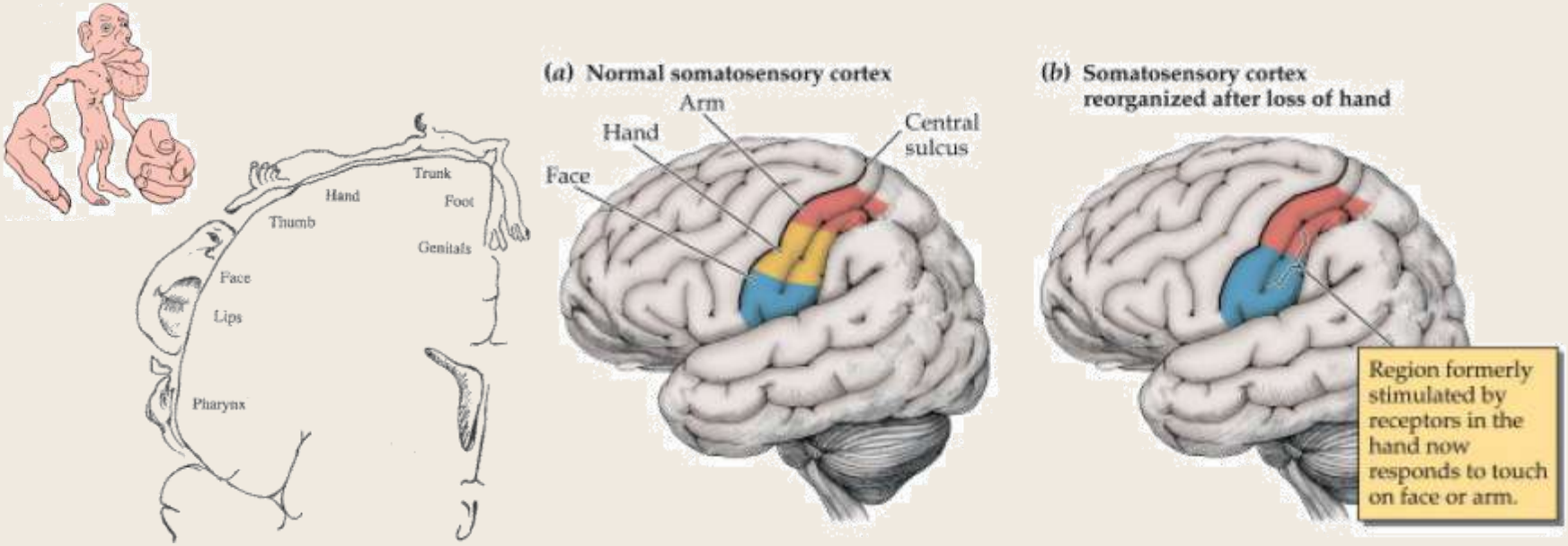
naceo -- 傷害 ; capio -- 感受



Ramachandran's Theory

- Phantom limb sensations could be the result of **reorganization of the sensory areas of the brain**

- Brain cortex **reorganized after the amputation**



Treatment

•**Antidepressants**, **spinal cord stimulation**, **hypnosis, acupuncture** and **biofeedback**. Unfortunately, most methods have failed to bring about any constant relief.

Mirror Box

Neural prosthetic devices

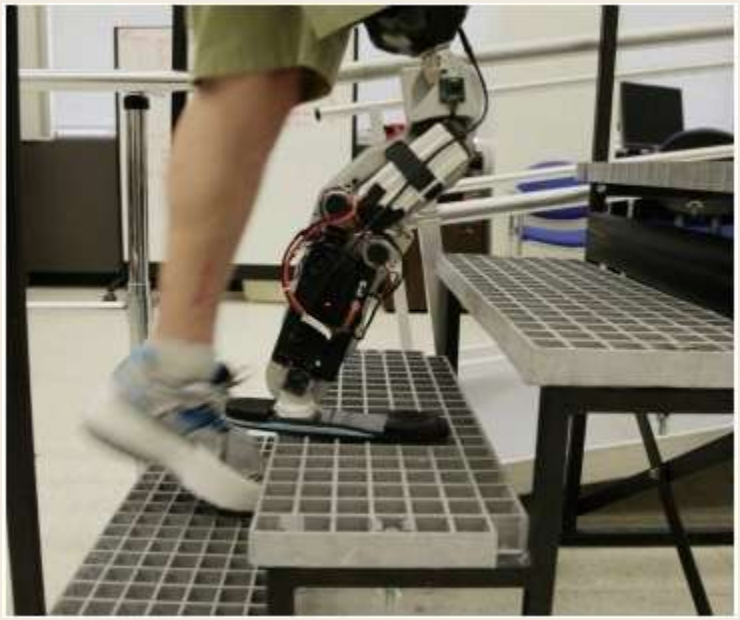
- Patient still has the capacity to think and form intentions
- In spinal cord injuries, strokes, neurons that carry commands from the brain to muscle can be injured
- In amputation, both nerves and muscle are lost

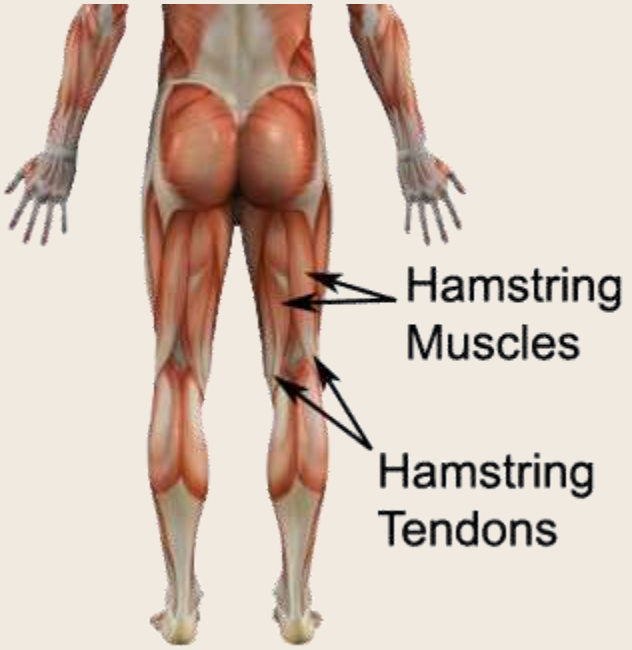
Muscle Controlled Prosthetic Leg

• Each muscle contraction can control only one motion, the range of motions is limited

•Vawter's example :

• Nerves from hamstring were wired to the prosthetic





Muscle Controlled Prosthetic Hand

- Nigel's example :

Using Brain Signal

- EEG :

  Using non-invasive electrodes on the scalp to record the electrical activity from the brain.

  inexpensive no medical complications

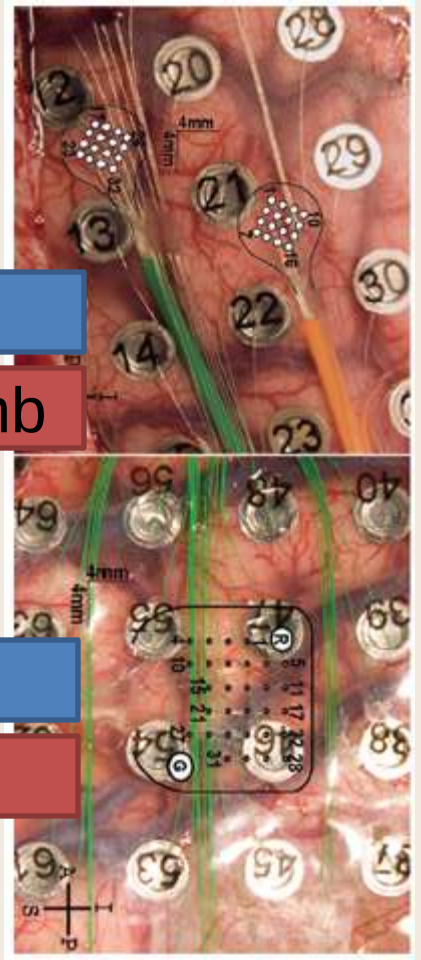
  imprecise, signals are better on upper limb

- Electrocorticography (ECoG) :

  Electrodes are placed on the brain.

  better reading

  invasive, may have infection or bleeding



Using Brain Signal

- Magneto Encephalography (MEG) :

  Reads magnetic fields produced by the electrical stimuli

  non-invasive

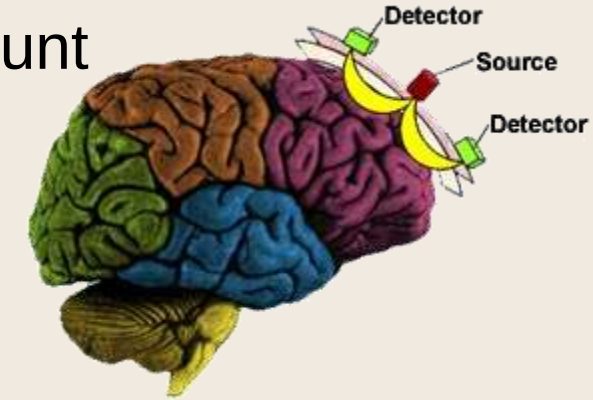
  expensive

- Functional Near Infrared Imaging (FNIR) :

  Identifies the parts of the brain producing stimuli by the increase in the amount of blood

  non-invasive, inexpensive

  not precise



DARPA's Mind-Controlled Prosthetic Arm

- Project costs : over $100 million

Difference Types of Control

- Mind-controlled doesn't always mean faster

- But for the average user, some delicacy of control might be preferable to record-breaking speed.

Reference

- MIT news 2007
- http://blogs.discovermagazine.com/
- DARPA Projects
- http://www.canada-meg-consortium.org/