Dynamic Reorganization of Referred Sensations by Movements of Phantom Limbs

Authors: VS Ramachandran, David Brang, Paul D. McGeoch

Journal
- NeuroReport is a channel for rapid communication of new findings in neuroscience.
- Publisher: Lippincott Williams & Wilkins
- Impact Factor: 1.656
- First issue was published in September, 1990

Authors
Vilayanur S. Ramachandran, MD, PhD
Director at the University of California, San Diego’s Center for Brain and Cognition (CBC)
Developed mirror therapy to mobilize paralyzed limbs in stroke victims and to treat chronic complex regional pain syndrome (CRPS)

Authors cont’d
David Brang, MA
Past Lab Partner – Post-Doc Researcher from Northwestern University
Graduate student at UCSD’s Department of Psychology

Authors cont’d
Paul D. McGeoch, MD, MRCP
Visiting Scholar
Studies: central post-stroke pain (CPSP), and how the brain generates one’s body image

Background to paper...
Continued experience of sensations and presence of a missing limb after amputation

This experiment shows the overlapping of these areas when amputation occurs, and consequently the convergence of somatic sensations in two specific regions of the body.
**Descriptions of phantom limbs**
- **Painful** and difficult (sometimes impossible) to voluntarily move
- **Movable** and not painful
- **Paralyzed

Ramachandran 1996

**What is ‘Learned Paralysis’?**
- Before amputation, the arm is paralyzed: every time that a sensory message was sent from the motor cortex to the arm, the brain continually received contradictory feedback that the arm was not moving.
- the brain ‘learns’ that the arm is fixed in that position. Therefore, when the arm is amputated the brain still ‘thinks’ the arm is fixed in the previous position.

(Ramachandran, 1996)

**Mirror Box**

*Figure 1. The mirror box. A mirror is placed vertically in the corners of a wooden air conditioning box whose top and front surfaces have been removed. The patient places his entired in the box. The mirror shows the patient that the phantom hand has been removed.*

(Ramachandran, 1996)

**What ‘kind’ of phantom did D.S. have?**

**Reference fields?**
“Sensory stimuli applied to the ipsilateral face are felt as referred sensations to the missing (phantom) arm, often producing a topographically organized map of the hand on the face with clearly delineated digits described as ‘reference fields’ (RFs)’ (Ramachandran et al. 2010)"

“After arm amputation, the sensory input from the face [and shoulder region in the cortex] which normally projects only to the [corresponding] area, ‘invades’ the vacated territory corresponding to the denervated hand”

- 8 sessions in one day
- Light touch: tip of a blunt pencil
- Cool stimulus: cotton bud simply dipped in ice water
They wondered whether changes in RF topography would occur if the patient were to move his phantom to alter its posture from this resting position.

For each of the 8 sessions that were performed on D.S.:
- First: mapped reference fields while in rest position (full pronation)
- Second: mapped reference fields while in the active position (thumb opposed against fifth finger – partially supinated)
- This was done on the face and shoulder and identical results were found each time
- After 2 months D.S. returned to undergo 10 sessions in one day
The change in topography was limited to touch stimulus.

A $2 \times 2 \chi^2$ analysis comparing RFs (thumb/pinky) to phantom position change (rest/movement) yields a significant difference of reported locations to light touch.

RFs are dynamic – not static
First demonstration of both rapid and large-scale alterations of plasticity of cortical topography
Cool stimulus referrals dissociate from light touch and reference fields remain unchanged after movement of the phantom.
Bibliography

- http://cbc.ucsd.edu/lab.html
- http://cbc.ucsd.edu/research.html

Videos on mental trickery regarding senses:

- http://www.youtube.com/watch?v=sxwn1w76ivk