

Sensory Retraining

Reflections on using mirror feedback in stroke rehabilitation

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Our senses are the windows through which we perceive our environment. Hearing, vision, taste, smell, and the sense of touch together provide our mind with an inner picture of the outer world.

Lundborg & Rosen, 2017



Let's start with a brief review
of terminology

Mirror (box) therapy or mirror visual feedback:

simply looking at the image

= imagery preparation/ somatosensory stimulation

unilateral stimulation reflected in the mirror

= sensory observation

= somatosensory stimulation

bilateral stimulation with the target limb behind the mirror

= sensory retraining

unilateral stimulation hidden behind the mirror

= somatosensory stimulation

= enhancing synchiria » unilateral stimulation

experienced as bilateral (Moseley & Wiech, 2009)

Sensation vs. Sensory Perception



Top
down

Perception
Response

Modulation
Transmission

Stimulus

Environmental interaction



Bottom
up

Types of somatosensation

**Somatosensation =
sensations from the (outer)
body**

Pain

Pressure

Light touch

Temperature

Proprioception

Vestibular



Other sensory modalities

Vision

Hearing

Taste

Smell

Breathing, thirst, hunger? (*Eccleston, 2018: Embodied*)

Taxonomy

(Merskey & Bogduk, 1994)

Esthesia = feeling or sensation

Hypoesthesia = decreased sensation

Paraesthesia = pins and needles

Dysethesia

Algesia = pain

Analgesia = absence of pain

Hyperalgesia = increased response to a painful stimulus

Hypoalgesia = decreased response to a painful stimulus

Allodynia = painful response to a non-painful stimulus

Consequences of nerve injury

Sensory loss

numbness

dysesthesia (crude or non-discriminative sensation)

Sensory gain

pins and needles

allodynia

dysesthesia (abnormal sensation) (Spicher, 2006)

Conditions with sensory involvement



Top
down

Perception

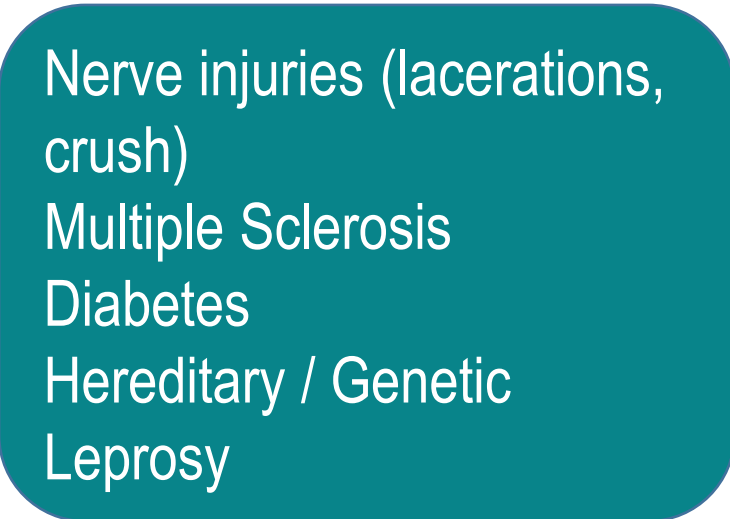
Response

Modulation

Transmission

Stimulus

Environmental interaction



Nerve injuries (lacerations,
crush)
Multiple Sclerosis
Diabetes
Hereditary / Genetic
Leprosy



Bottom
up

Conditions associated with sensory perception changes



Top
down

Stroke
Chronic pain
Autism
Mental health conditions

**Perception
Response**

**Modulation
Transmission**

Stimulus

Environmental interaction



Bottom
up

Functional consequences of sensory disorders

Loss of control

Stigma

Limitations in activities

Self

Intimacy

Fatigue

Anorexia

Limited participation

increased vigilance



**The sensations from our skin inform TOUCH . . .
a blend of the physical, physiological, and the emotional**

Sensory Retraining



Sensory Re-education: Graded application of cutaneous stimuli to an adjacent area of skin with hypoesthesia (*numbness*) or altered perception (*dysesthesia*)

Desensitization: Direct stimulation to painful area to adaptively raise the threshold or otherwise alter signal transmission (Yerxa et al, 1983; Fisher & Boswick, 1983)

What is hypersensitivity?

Increased response to a **noxious** stimuli?

Hyperpathia

Increased response to a **non-noxious** stimuli?

Hyperesthesia or allodynia

Inability to accurately perceive/discriminate/localize **sensory qualia**?

Hypoesthesia or dysesthesia, summation



How does this fit with post-stroke recovery?

What type of sensory alterations are experienced by persons after a stroke?

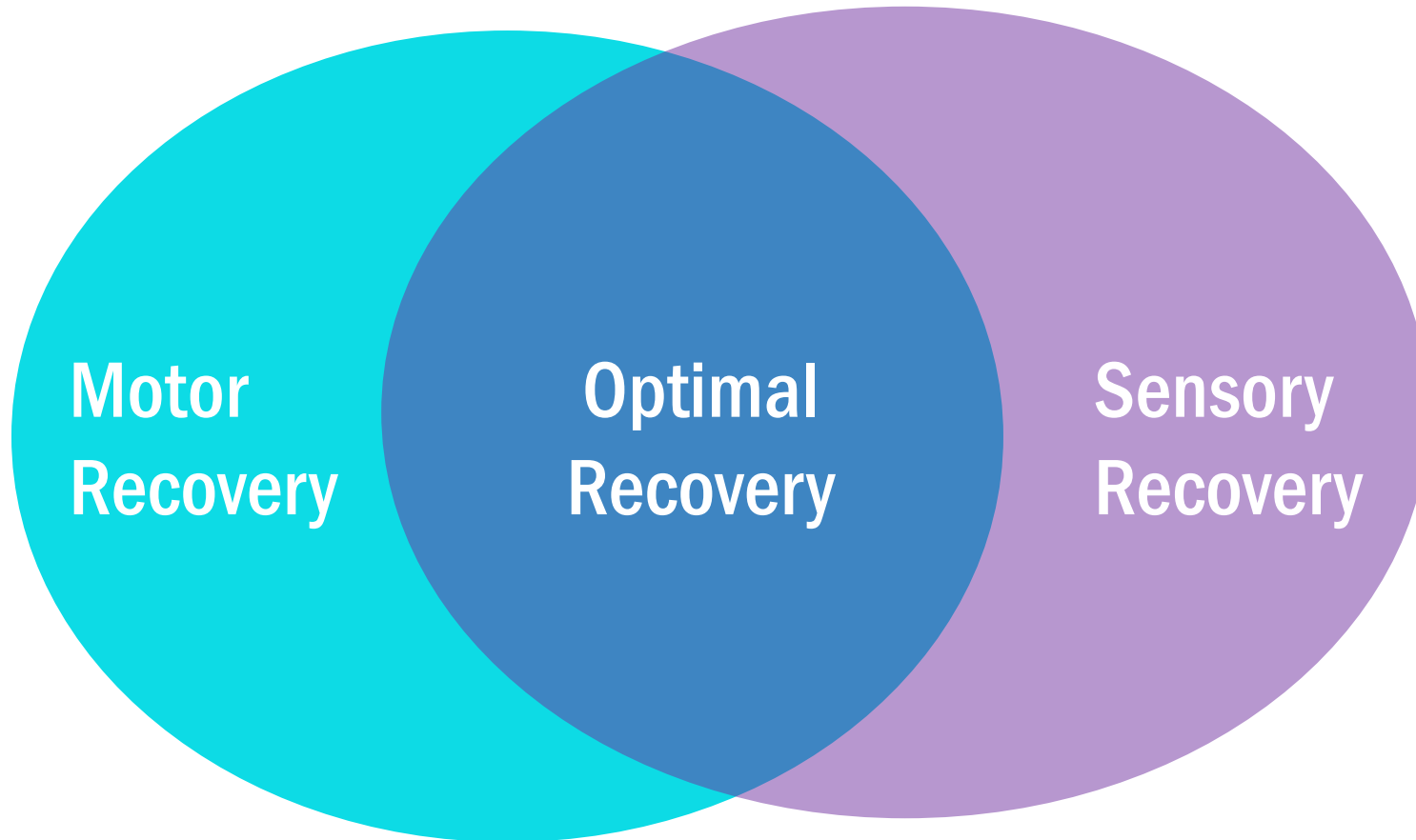
Both immediate (*sensory loss*) and later onset (*sensory gain*)

Included changes in ability to process multiple forms of sensory feedback (*sensory integration*) (Alwawi et al, 2020)

Prevalence: up to 85% in affected side immediately post-stroke (15% in less affected side) cutaneous changes

- between 30-40% at 6 months post stroke (Bowden et al, 2014)

Sensory recovery is critical for motor recovery post-stroke



Optimal motor recovery needs sensory inputs, and **multimodal is ideal** (Bolognini et al, 2016)

Optimal sensory and motor recovery translates to improved safety, self-care and independence

(Bowden et al, 2014)

Sensory retraining principles

Target the higher-level **discrimination** functions of sensation such as localization, differentiating shapes and textures (rather than the conscious experience of somatosensations?) (Moseley & Weich, 2009)

Cross-modal inputs (Carey & Matyas, 2005; Carey et al, 2011)

Compare to areas of normal sensation (Carey et al, 2011)

‘Mindful’ sensory experience or ‘Attentive exploration’ - concentrating on comparing the experience of different modalities

Grade the stimuli by increasing the similarity

Play along! Try closing your eyes and stroking your hand or forearm with something wooden, then plastic, and then metal. Really think about how it feels. Compare how it feels on your face vs your forearm or even your tummy

Sensory retraining toolkit

Fabric scraps

Buttons made of different materials, different sizes, different number of holes

Lego bricks

Textured media (like beans) with other objects 'hidden' inside

Foam/sponge/plastic cut outs of different shapes

Plastic caps of different sizes

Letters or dots made of puff paint on stiff cards; also lines of different length

Activities

Draw a 'grid' with water-based marker to use for localization

Apply moving light touch (e.g. stroking with a cotton swab) and ask 'Was it moving toward your shoulder or hand?'

Ask the person to touch something with their eyes closed and describe it to you

**e.g. an apple or orange that has been in the refrigerator
a (textured) pottery mug**

What if sensation is very poor ?

Augment the feedback (*cross-modal inputs*)

Weight

Texture

Colour to increase visual attention

Perception of temperature (*i.e metal feels cool*)

Auditory elements (*crackling, squeaking*)

Proximal inputs when possible

Speed of stimulus (*longer, slower*)

What if the person has allodynia or other sensory gain?

Mirror visual feedback has been shown to be effective in post-stroke CRPS (Smart et al, 2016)

Direct stimulation of the area of allodynia is likely to increase pain, not decrease it (Spicher, 2006)

Work proximally in an area of dysesthesia or hypoesthesia

Progress towards the area of allodynia

Reduce all direct inputs temporarily

Proprioceptive retraining

Weight-bearing on a ball or balloon

Rolling a cylinder with hand or foot

Practicing joint position exercises (duplicating pictures)

Motor imagery

Stretchy tape for augmented cutaneous feedback

(Harris & Hebert, 2015; Hagert, 2010; Valdes et al, 2014)

Isn't this supposed to be about mirror visual feedback?



- 1) Mirror feedback is a form of sensory stimulation
- 2) Adding cutaneous sensory stimulation makes it **multi-modal!**

Sensory strategies with a mirror box

Unilateral sensory stimulation (unaffected hand)

****mindful experience of the sensory qualia, not just focusing on the visual image**

Bilateral sensory stimulation

Unilateral sensory stimulation (affected hand only – induce synchiria)

Tactile discrimination training (Moseley & Wiech, 2009)

Sensory + Motor strategies (with a mirror box)

Hand-over-hand

Moving through a medium (shaving cream, beans, rice)

Task-based object interaction (rolling, holding, squeezing, pushing)

Rhythmic tapping to music, metronome

Squeezing a squeaky toy

Crumpling paper

References

- Alwawi DA, Dean E, Heldstab A, Lawson LM, Peltzer J, Dunn W. A Qualitative Study of Stroke Survivors' Experience of Sensory Changes. *Can J Occup Ther.* 2020;87(4):298-306. doi:10.1177/0008417420941975
- Bolognini N, Russo C, Edwards DJ. The sensory side of post-stroke motor rehabilitation. *Restor Neurol Neurosci.* 2016;34(4):571-586. doi:10.3233/RNN-150606
- Bowden JL, Lin GG, McNulty PA. The prevalence and magnitude of impaired cutaneous sensation across the hand in the chronic period post-stroke. *PLoS One.* 2014;9(8):1-7. doi:10.1371/journal.pone.0104153
- Carey LM, Matyas TA. Training of somatosensory discrimination after stroke: Facilitation of stimulus generalization. *Am J Phys Med Rehabil.* 2005;84(6):428-442. doi:10.1097/01.PHM.0000159971.12096.7F
- Carey L, Macdonell R, Matyas T. SENSE: Study of the Effectiveness of Neurorehabilitation on Sensation: A Randomized Controlled Trial. *Neurorehabilitation and Neural Repair.* 25(4) 304–313.
- Dellon, AL. *Evaluation of sensibility and re-education of sensation in the hand (3rd ed.)*. Williams and Wilkins: Baltimore. 1988.
- Harris JE, Hebert A. Utilization of motor imagery in upper limb rehabilitation: a systematic scoping review. *Clin Rehabil.* 2015;29(11):1092-1107. doi:10.1177/0269215514566248
- Merskey H, Bogduk N (eds). *Classification of Chronic Pain: descriptions of chronic pain syndromes and definitions of pain terms*. International Assoc. for the Study of Pain. Elsevier: NY. 1994.
- Moseley GL, Wiech K. The effect of tactile discrimination training is enhanced when patients watch the reflected image of their unaffected limb during training. *PAIN* 2009;144(3):314–9. doi:10.1016/j.pain.2009.04.030

References

Rosen B, Lundborg G. A New Tactile Gnosis Instrument in Sensibility Testing. *J Hand Ther* 1998;(December):251-257. doi:10.1016/S0894-1130(98)80020-31.

Smart KM, Wand BM, O'Connell NE. Physiotherapy for pain and disability in adults with complex regional pain syndrome (CRPS) types I and II. *Cochrane Database Syst Rev*. 2016;2016(2). doi:10.1002/14651858.CD010853.pub2

Spicher C. Handbook for Somatosensory Rehabilitation (English ed.) Sauramps Medical: Paris. 2006.

Valdes K, Naughton N, Algar L. Sensorimotor interventions and assessments for the hand and wrist: A scoping review. *J Hand Ther*. 2014. doi:10.1016/j.jht.2014.07.002

LET'S TALK!

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