Multisensory Body Illusions

Corps et cognition: l’embodiment

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Theory of Pain Laboratory

Studying neurotypical individuals

How to investigate in the undamaged, typically-developed, brain concepts as the Body Schema?

The perfect experiment would be to compare:
– A condition in which participants have a body
– A condition in which participants have no body

Alternative approaches?

Multisensory Body Illusions

Body Schema: representation of one’s own posture at each moment (built by integrating of information arising from different sensory modalities).

What if we «trick» the brain by providing inconsistent information between the sensory channels?
– How is sensory processing of one channel affected by inconsistent information from a different channel?
– How is my sense of body affected by the presence of inconsistent information?
Summary

_multisensory body illusion_

- Visual enhancement of touch
- Pinocchio illusion
- Rubber-hand illusion

Visual Enhancement of Touch

Tactile detection is faster when looking at your own body, even if the representation of your body is not informative about the occurring touch.

Participants were touched by one or by two simultaneous spatially-separatet stimuli. Below which spatial distance, the two stimuli are mistakenly perceived as one?

Kennett S et al. (2001). Current Biology

Participants could see:
- their own arm
- magnified arm
- an object
- nothing

The tactile events were never visible by participants.

Kennett S et al. (2001). Current Biology
Two-points discrimination

Participants were stimulated in their forearm, whilst they saw an arm, a foot or an object.

Serino A et al. (2007). Neuropsychologia

Vision of an arm improves only in subjects with low tactile acuity (LA)

Serino A et al. (2007). Neuropsychologia

Vision of an arm improves a lot in brain damaged patients with impaired somatosensory function

Serino A et al. (2007). Neuropsychologia
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Inverse effectiveness law → signals from different modalities are more strongly integrated when modality-specific signals are individually less effective in producing a unisensory response.

In VET visual information is used to boost tactile sensation only when touch alone cannot solve spatial discriminations close to perceptual limits.

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Electrical Stimulation Thumb

ERP signals elicited by small electrical stimulations to the median nerve in order to generate small thumb twitches.

Longo M et al. (2011). Neuror. Letters
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Is the disk touching you with horizontal or vertical bars?

How much thin need the bar to be for not being able to tell the difference?

Transcranial Magnetical Stimulation on the primary somatosensory cortex cancels the effect


Two-points discrimination

Serino A et al. (2009). Cortex
Two-points discrimination

Viewing one’s hand

Serino A et al. (2009). Cortex

Two-points discrimination

Viewing one’s foot

Serino A et al. (2009). Cortex

Orientation Discrimination Task

TMS on both the ventral intraparietal sulcus (posterior parietal cortex) and primary somatosensory cortex

Konen C & Haggard P (2014) Cerebral Cortex

10/24/2016
Visual Enhancement of Touch

VET → Non-informative vision of one’s body boosts the signal of corresponding parts of the somatosensory cortex (and surroundings)

Vision contributes to better understand the bodily space to which tactile information is referenced.

An integrated visuo-tactile representation of the body (in vIPS) possibly mediates this effect

Serino & Haggard (2010). Neuroscience and Biobehavioral Reviews

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Pinocchio Illusion

Participants are blindfolded whilst picking their nose with their right hand. The experimenter vibrates the arm’s tendons giving an illusion of arm-extension. By integrating the (correct) tactile and (altered) proprioceptive information, participants sometimes believe to have an extremely long nose.

Pinocchio Illusion


De Vignemont F et al. (2005). Current Biology

Pinocchio Illusion

Michael & Park (2016). Schizophrenia Research

Rubber-hand illusion

Participants see a fake hand while their real hand is hidden from their sight. When the experimenters brush simultaneously both the real and the rubber fingers, participants:

- feel the brush strokes where the fake and not the real hand is touched.
- sometimes believe the fake hand to be theirs.

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Rubber Hand Illusion

Proprioceptive drift
I feel my hand closer to the position of the rubber hand


Rubber Hand Illusion

Ownership

Longo M et al. (2008) Consciousness & Cognition

Rubber Hand Illusion & Visual Enhancement of Touch

Subjects with low tactile acuity have a benefit from the RHI

Longo M et al. (2008) Consciousness & Cognition
Rubber Hand Illusion

Longo M et al. (2008) Consciousness & Cognition

Temperature decrease in the stroked hand which is no longer felt as one’s own.

Such decrease does not extend to the whole body

Rubber Hand Illusion

Kammers et al. (2011) Neuropsychologia

RHI & Temperature: a causal relationship?

A pulse of current flowing through a coil of wire generates a magnetic field. If its magnitude changes with time, then it will induce a secondary current in any nearby conductor (THE BRAIN).

Transcranial Magnetic Stimulation (TMS)

Transcranial magnetic stimulation (TMS) produces a brief magnetic pulse that induces a small electric current in the brain, which can be used to momentarily interrupt or activate neural activity.
Rubber Hand Illusion (full body version)

- Explicit Ratings
- Temperature drop

Ehrsson HH et al., (2004), Science

Rubber Hand Illusion


Rubber Hand Illusion

Tsakiris M et al., (2007), Cereb. Cortex
Rubber Hand Illusion

Tsakiris M et al., (2010). Neuropsychologia

Rubber Hand Illusion

Tsakiris M et al., (2010). Neuropsychologia

Rubber Hand Illusion

Tsakiris M et al., (2010). Neuropsychologia
Interoception, defined here as the sense of the physiological condition of the body, is a ubiquitous information channel used to represent one’s body from within (temperature, heart pulse, respiration, visceral sensations, etc.)

- RHI has been always described as resulting multisensory conflict from exteroceptive information, from outside

- but RHI is associated also with interoceptive changes, such as the temperature drop in the disowned limb.

- RHI is associated also with the activity of the insular cortex, implicated also in interoceptive processing

Interoceptive awareness task: count mentally your own heartbeats (without checking your pulse). These are compared with the real beats monitored with ECG. Larger the accuracy between counted vs. real beats, the larger one’s awareness of one’s physiological states.
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The more one is aware of one’s internal physiological states, the more one resists to exteroceptive illusions about the state of your body.

Aspell JE et al., (2013) Psych Science

Cardio-visual paradigm

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Tactile-Proprioceptive Integration in PPC

Participants were touched simultaneously in their face and arm.

"was the arm touch higher than that in the face?"

TMS in PPC makes this task more difficult


Tactile-Proprioceptive Integration in PPC

TMS does not affect mere proprioceptive localization ("Is this arm higher/lower than..?"

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TMS does not affect mere tactile acuity («Is this face touch higher/lower than this other face touch?»)

TMS affects Tactile-Proprioceptive interaction