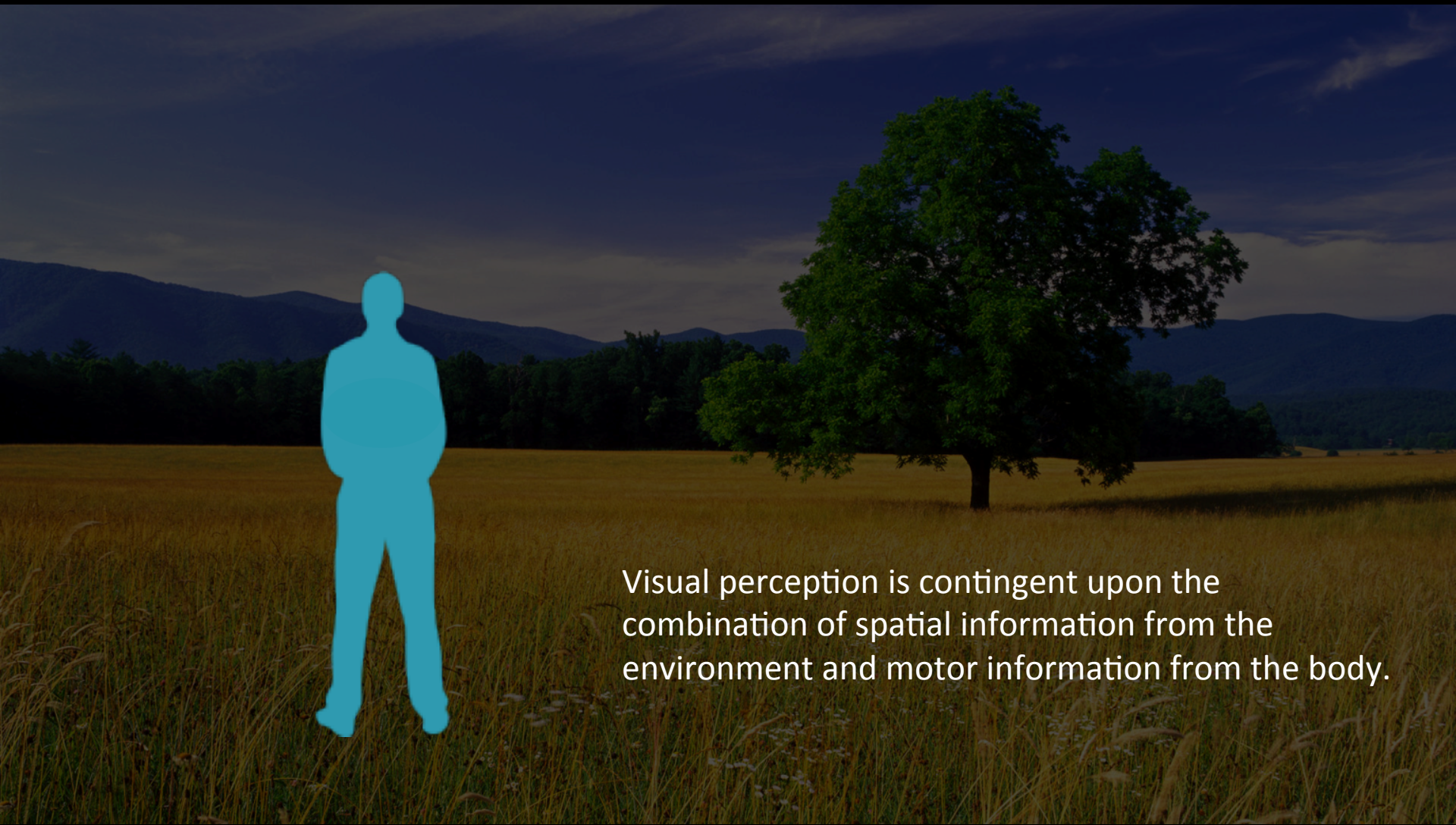


A functional approach to the representation of space for interacting with objects and people



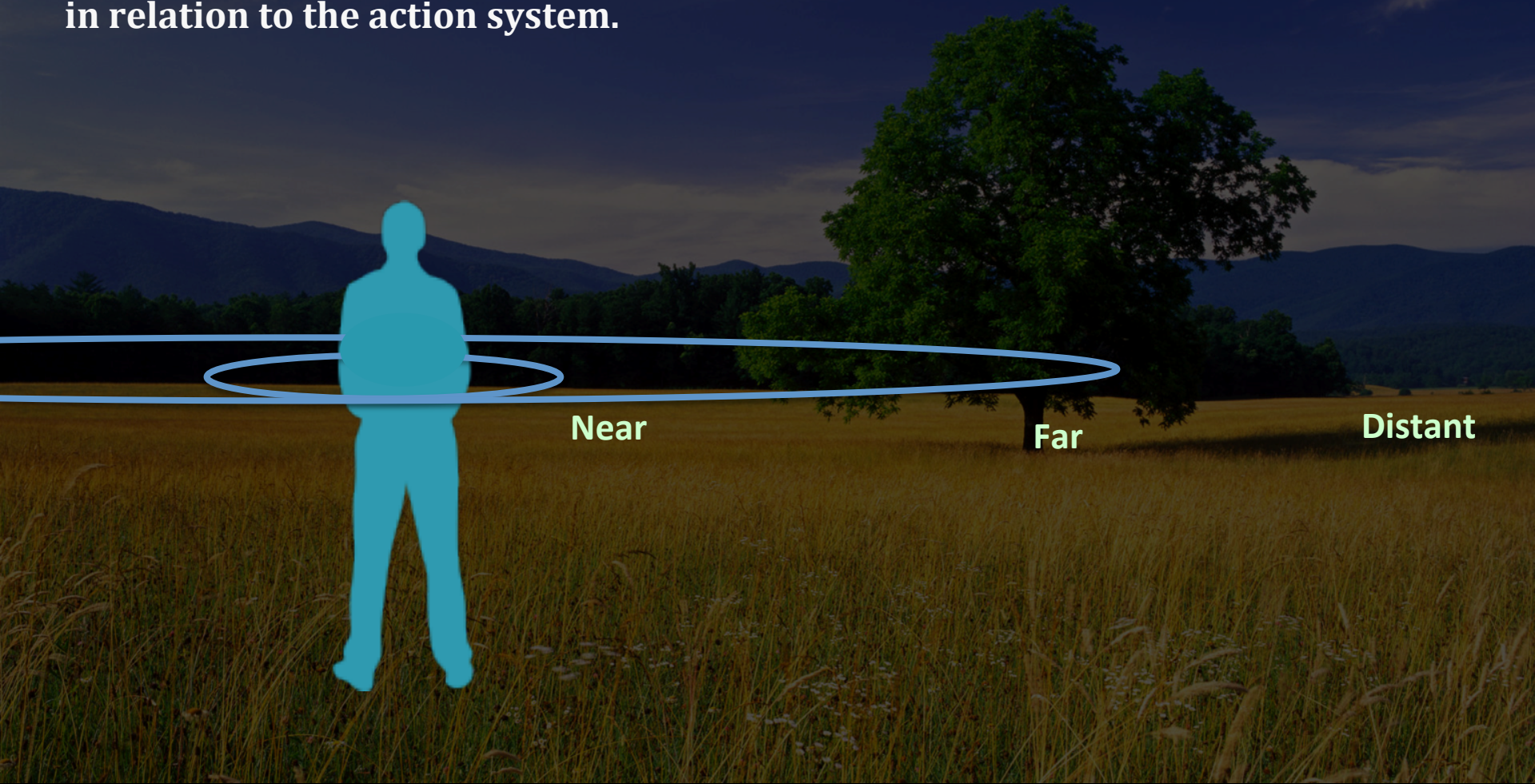
Yann Coello

*Cognitive and Affective Sciences Laboratory
University of Lille - France*



Visual perception is contingent upon the combination of spatial information from the environment and motor information from the body.

Visual space is not a continuum, but has a series of perceptual thresholds, in relation to the action system.



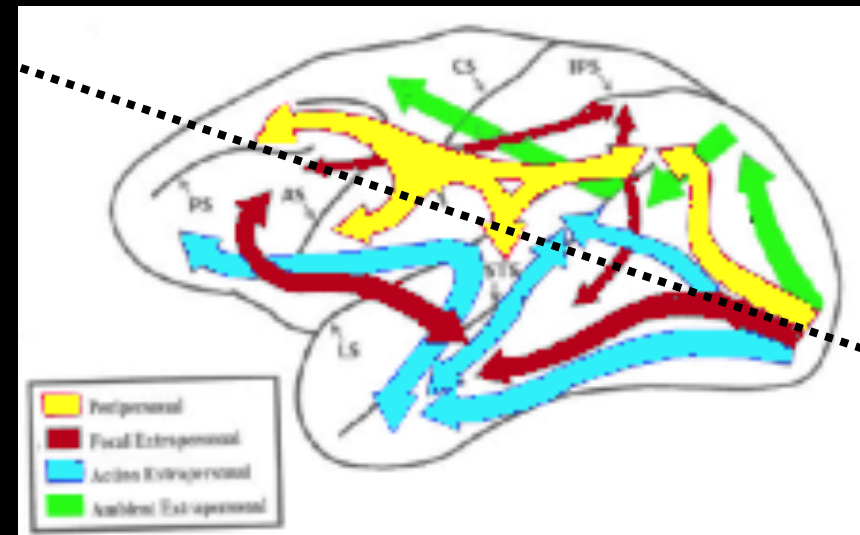
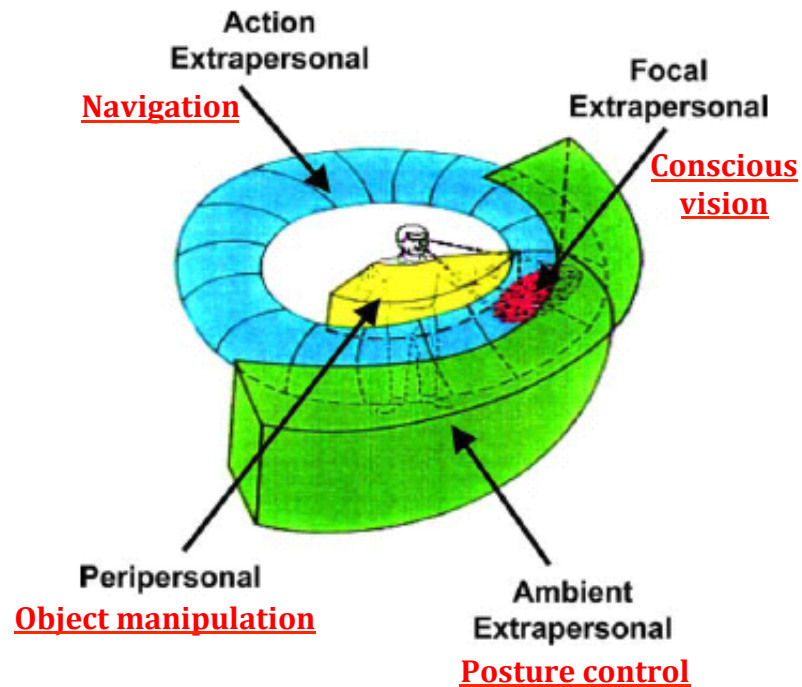
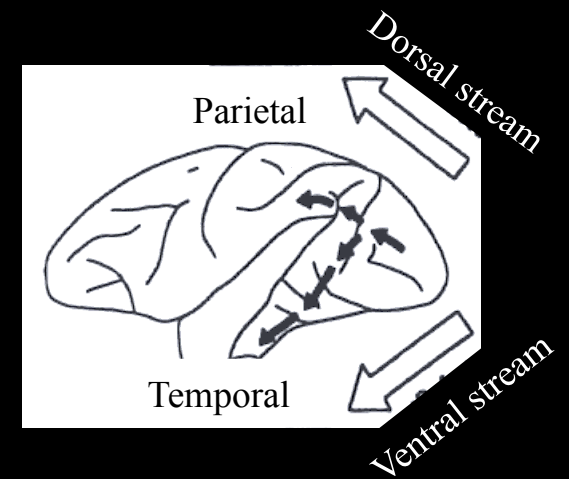
Near

Far

Distant

Functional Spaces

Previc, F.H. (1990, 1998)





Peripersonal

Extrapersonal

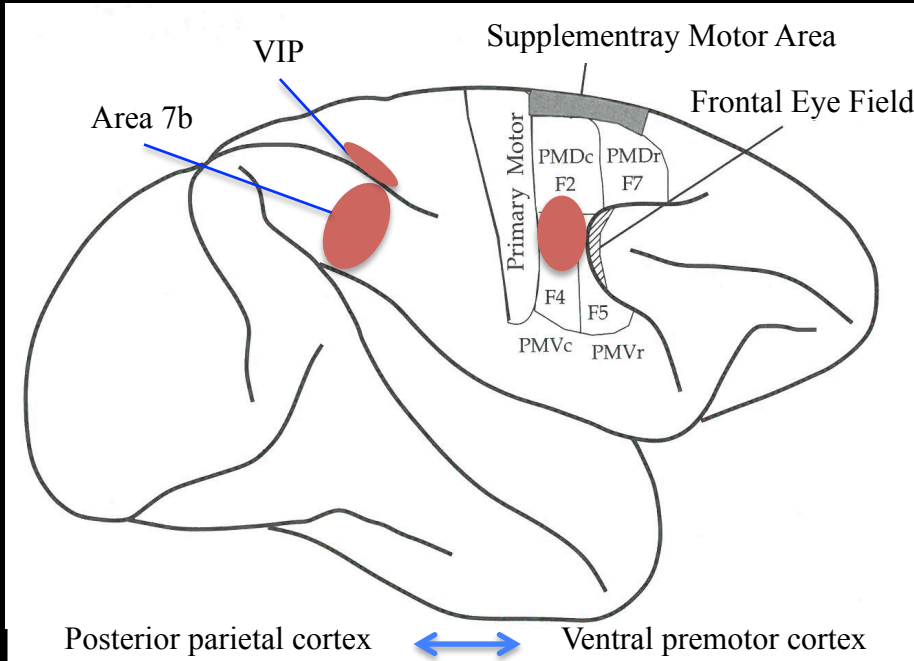
A diagram illustrating the concept of peripersonal space. It features a light blue silhouette of a person standing in a field of tall grass. A semi-transparent blue cylinder is drawn around the person, representing the peripersonal space. The top of the cylinder is labeled 'Peripersonal'. The background shows a landscape with rolling hills and a large tree under a cloudy sky.

Peripersonal

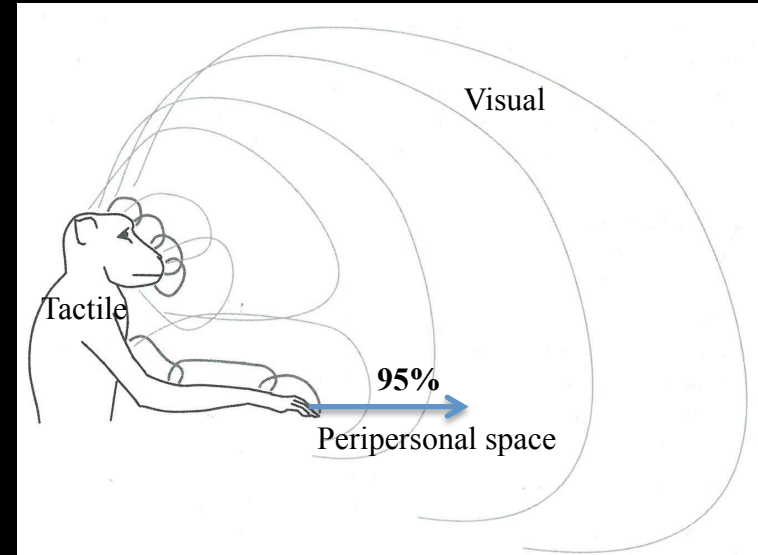
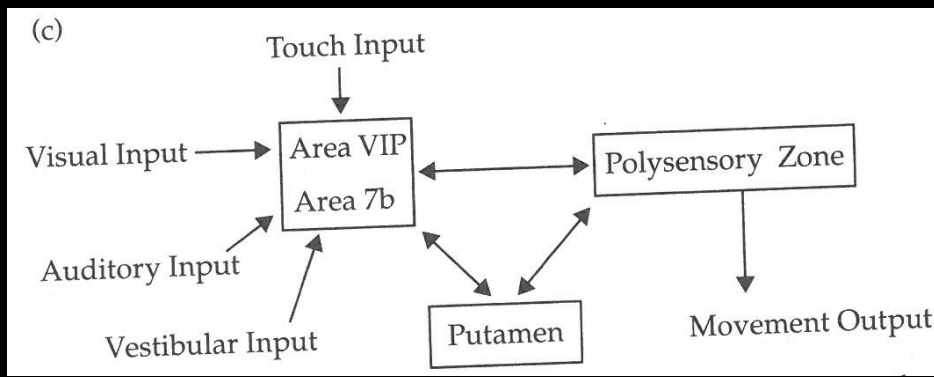
Peripersonal space is a complex interface between the body and the environment based on an interplay between sensory and motor processes, characterised by:

- Multisensory integration of objects features
- Contribution of the motor system to sensory processing

Multisensory integration in PPS



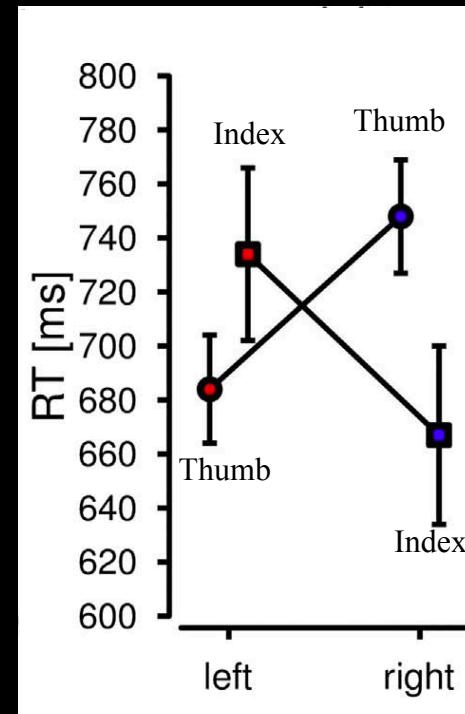
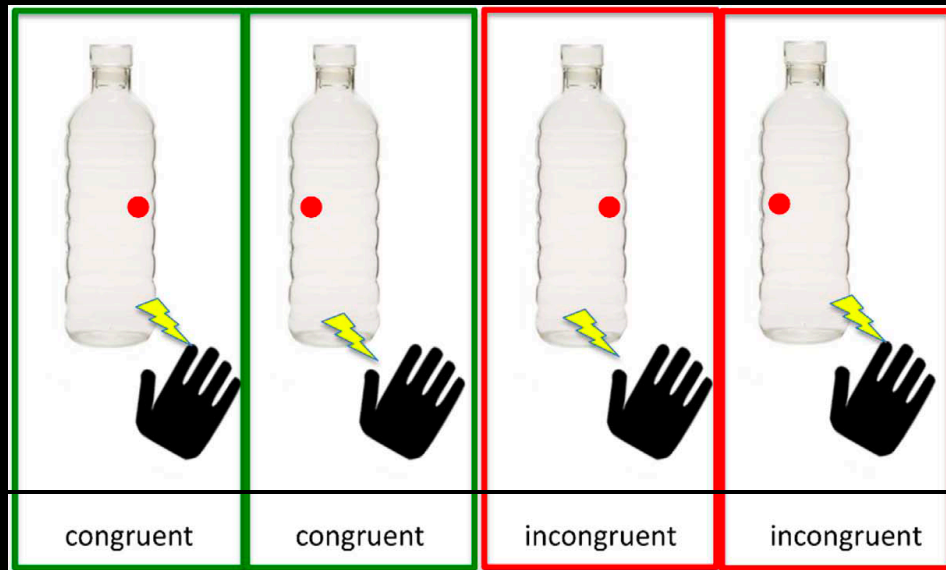
Receptive field of multisensory neurons



Mental space maps into the future

Anna Belardinelli^a, Johannes Lohmann^{a,*}, Alessandro Farnè^{b,c}, Martin V. Butz^a

Tactile stimulus detection task



Perceptual facilitation of multisensory integration

Multisensory integration in peripersonal
not extrapersonal space

Evidence for a contribution of the motor system to sensory processing in PPS



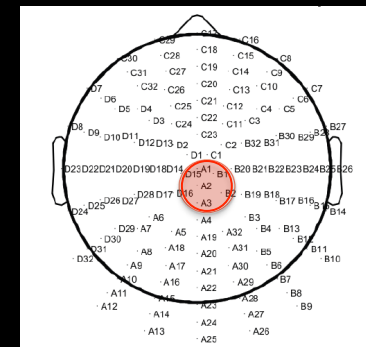
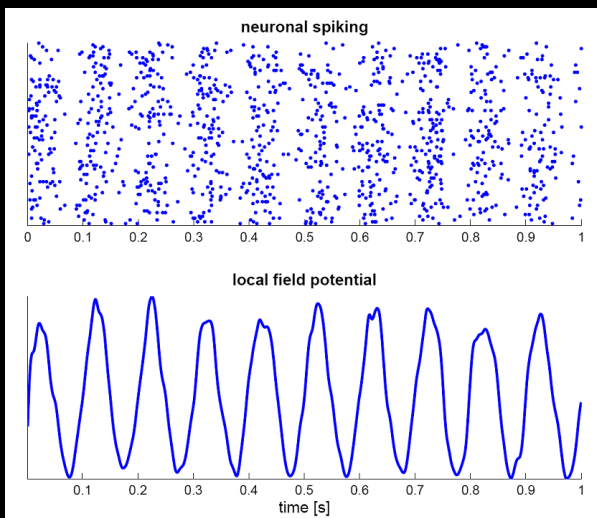
3D manipulable objects



Screen 4 m x 2 m,
Projector Christie 4 K, 120 Hz

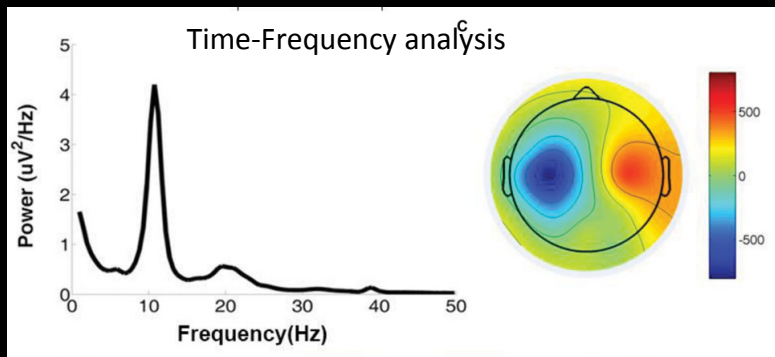


Time-Frequency analysis



Active Biosemi EEG
128 active electrodes

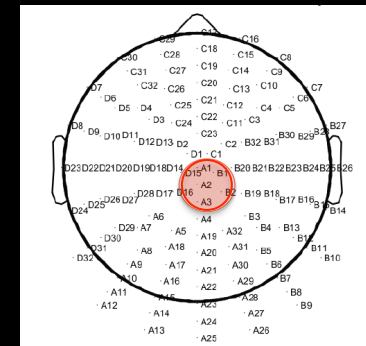
3D manipulable objects



μ rhythm (8–12 Hz) :

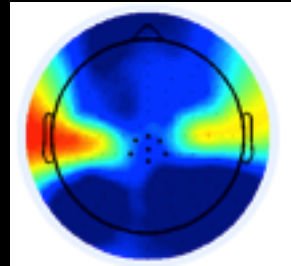
- Modulated by motor production & motor imagery
- Modulated by objects observation

Screen 4 m x 2 m,
Projector Christie 4 K, 120 Hz



Active Biosemi EEG
128 active electrodes

EEG Time - Frequency analysis: 8 – 13 Hz



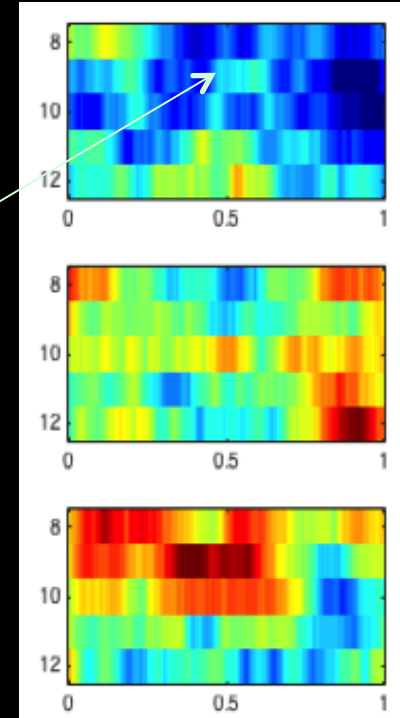
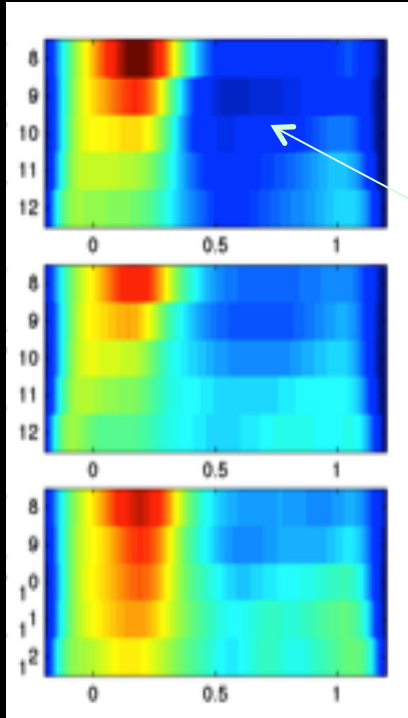
Perceptual category

Sémantic category

Peripersonal

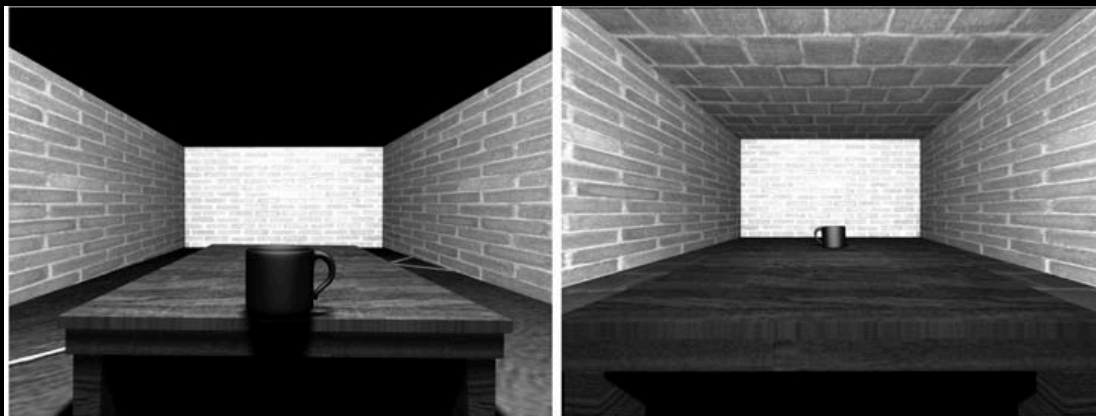
Boundary

Extrapersonal



μ desynchronisation

Coding of visual objects in peripersonal space, not in extrapersonal space, involves the motor system, whether the task is perceptual or cognitive

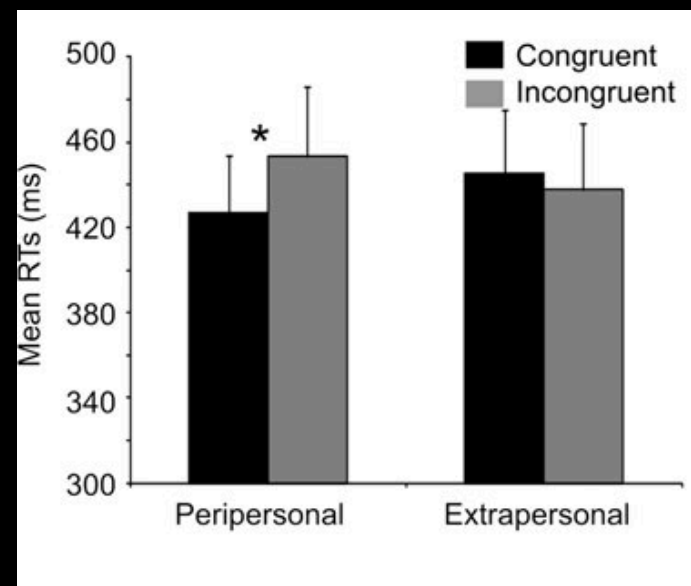


Task: Motor response as soon as the stimulus appears

Congruent trials : handle ipsilateral to the hand

Incongruent trials : handle contralateral to the hand.

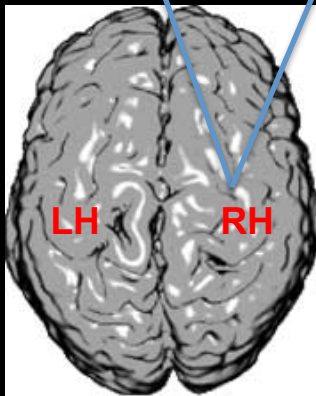
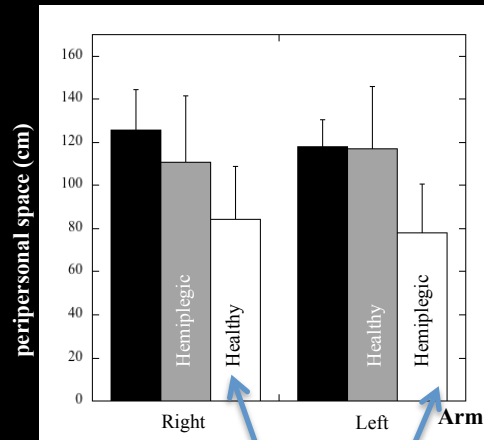
Perceptual facilitation of objects
in peripersonal space



Motor deficits alter the representation of peripersonal space



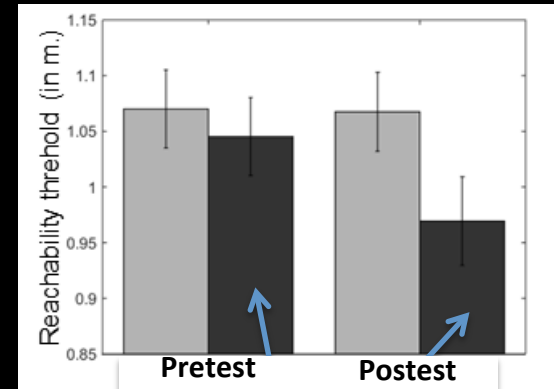
Upper-limb hemiplegia



Stroke patients

Bartolo et al. (2014)

Upper-limb immobilization

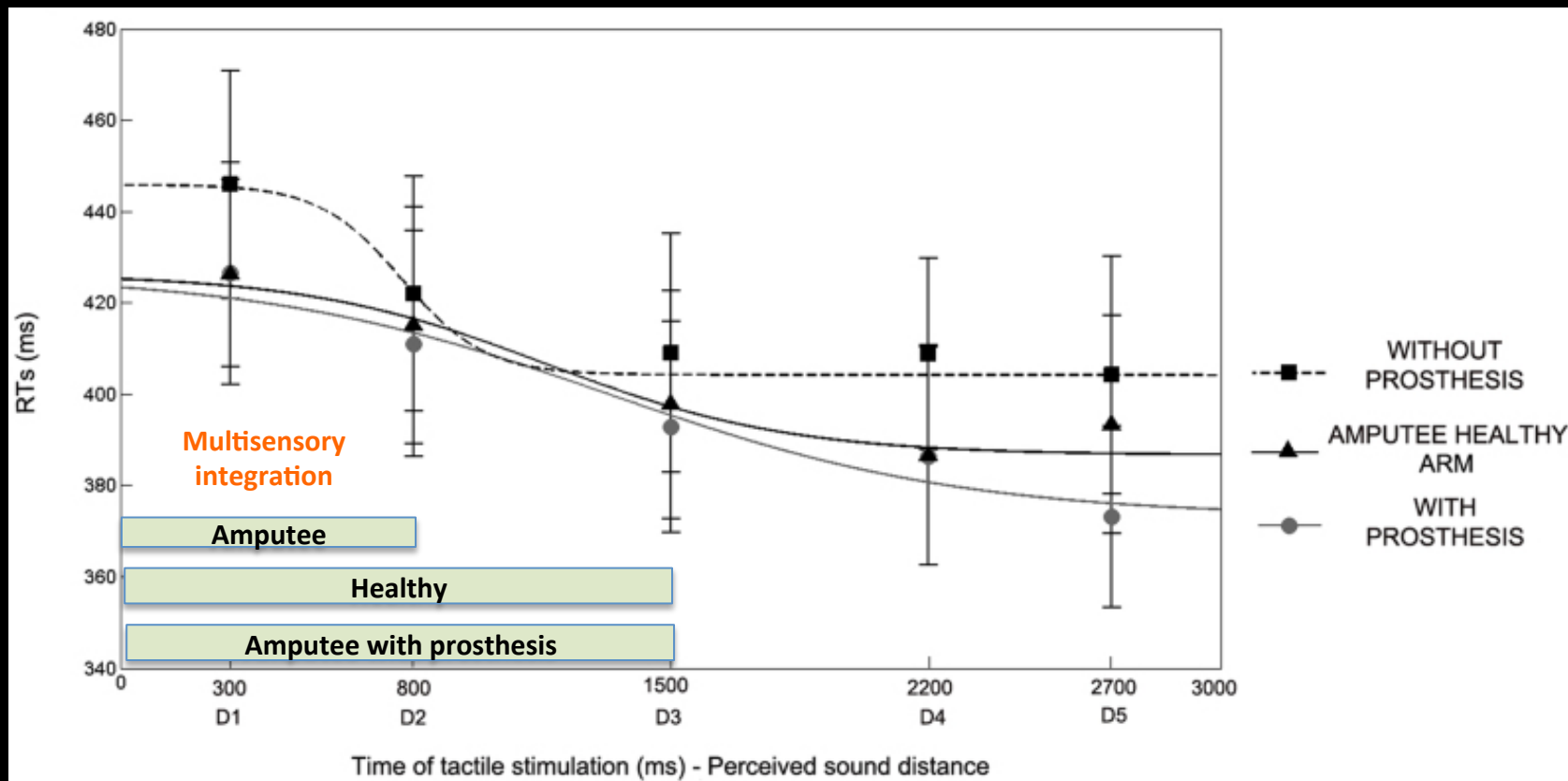


24 hours immobilization

Toussaint et al. (2018)

Reduction of multisensory integration (auditory-tactile)

Canzoneri et al., 2013



Measure of the critical distance at which an approaching or receding sound interacts with the processing of tactile stimuli at the upper limb.

Normal functioning of the sensorimotor system is thus a prerequisite for an accurate representation of peripersonal space

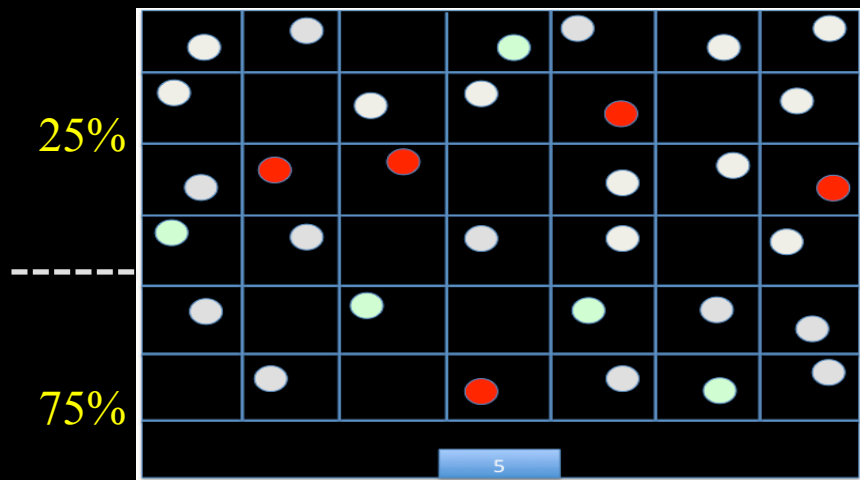
Peripersonal space depends the motor system but also object value



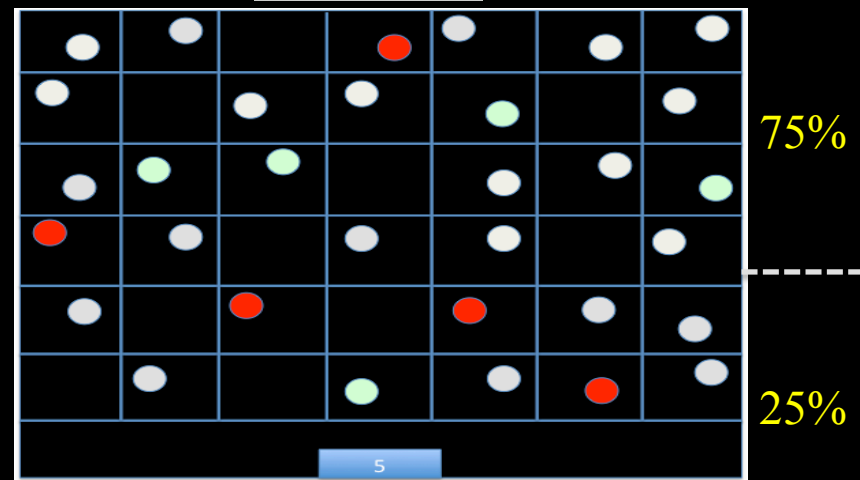


\pm positive/negative value

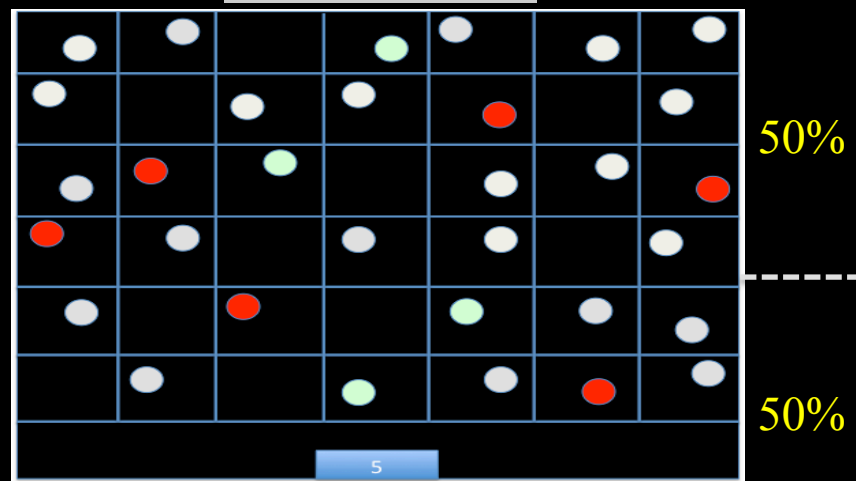
Near group



Far group

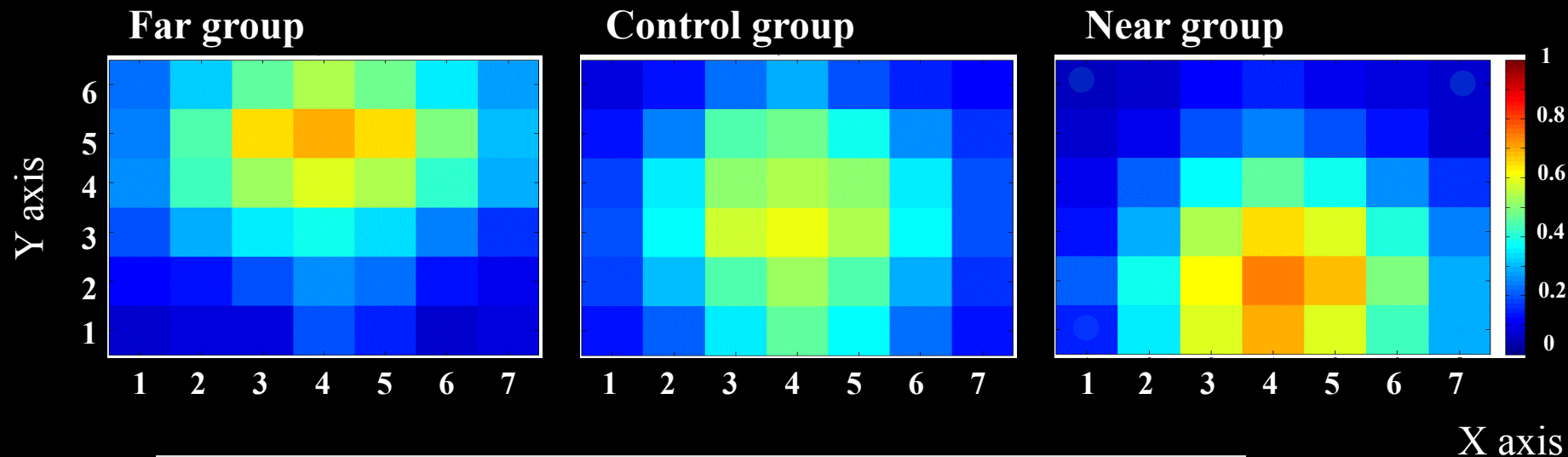


Control group

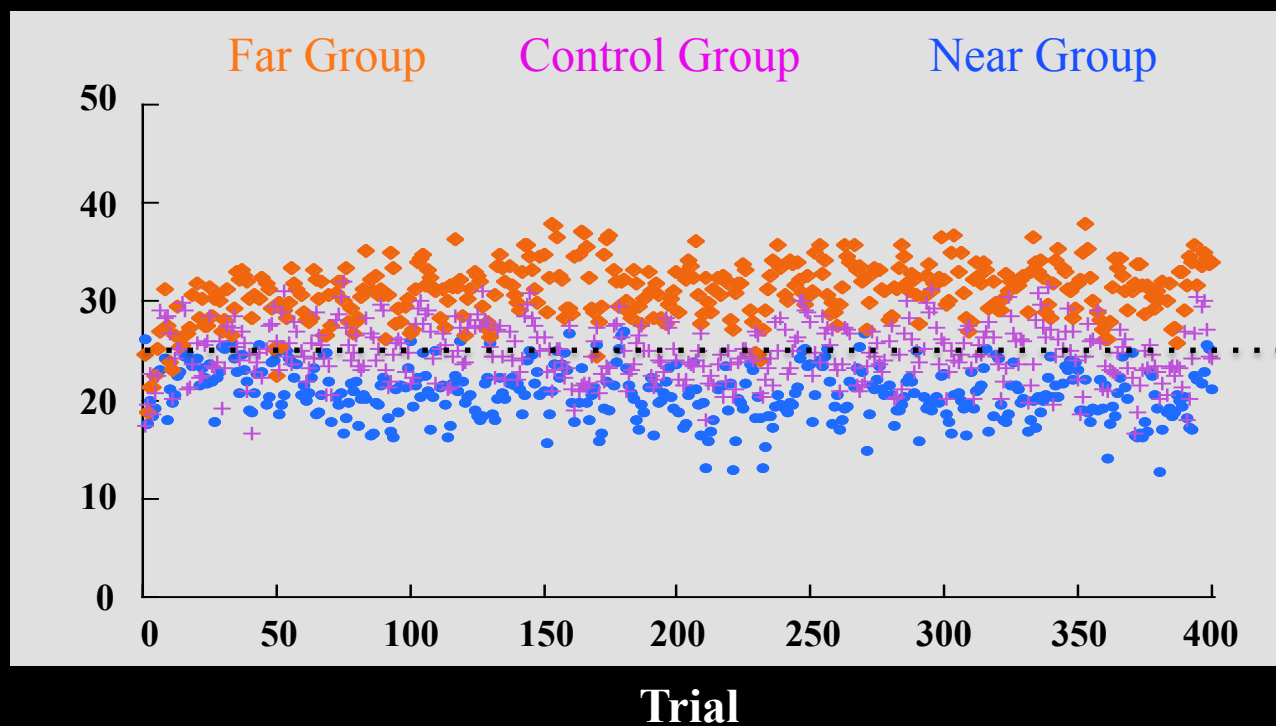


Task: Selects 10 targets in 40 successive blocks

Density map



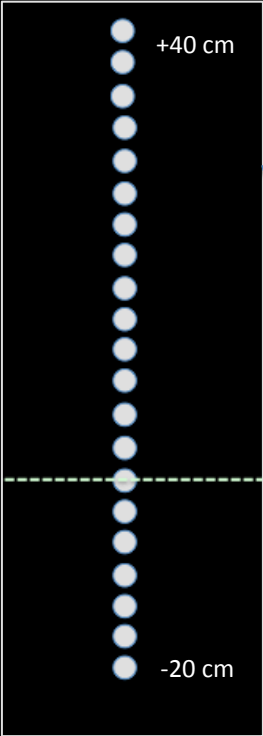
Mean amplitude of manual
reaching actions (cm)



+ 3.7 cm
- 0.2 cm
- 2.9 cm

Experimental design

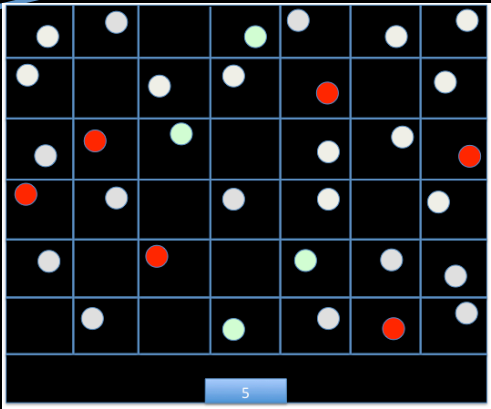
Pretest



**Reachability
Judgment**

31 targets
4 times
124 trials

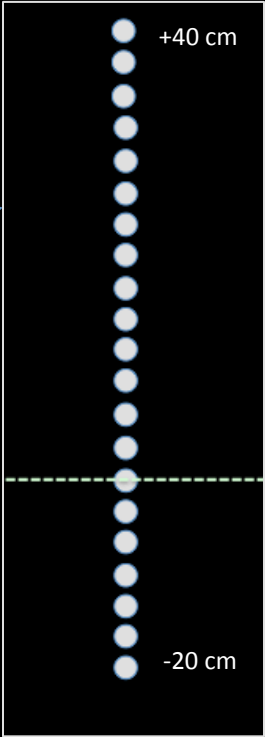
Time



Target selection

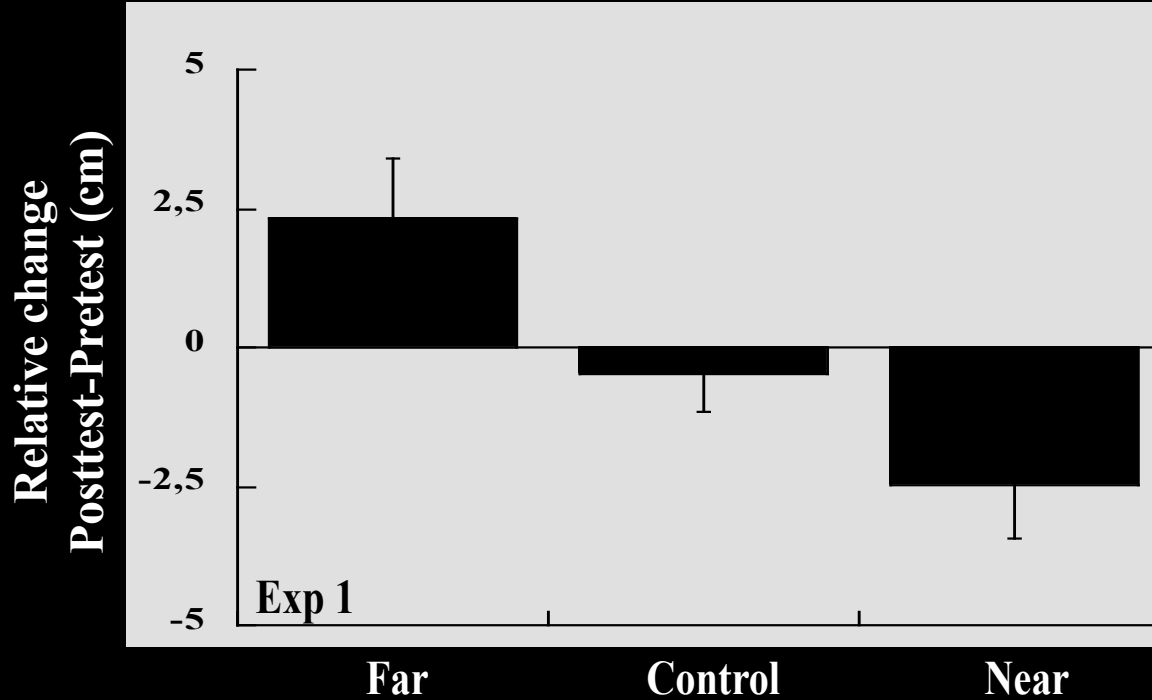
10 targets
40 blocks
400 trials

Posttest

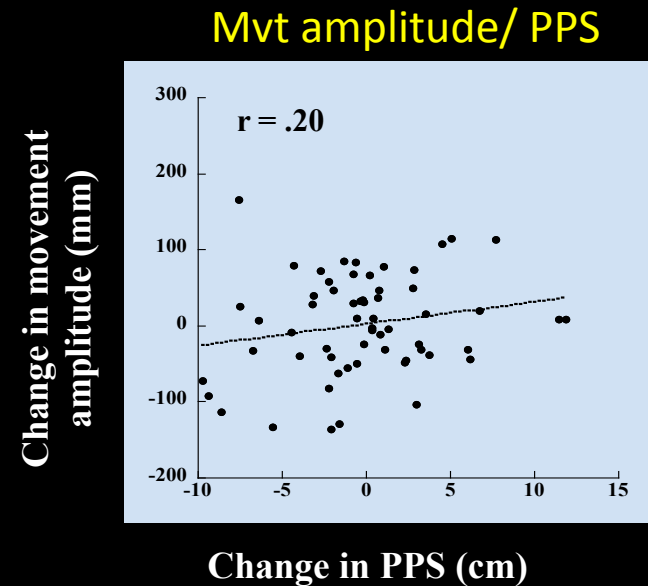
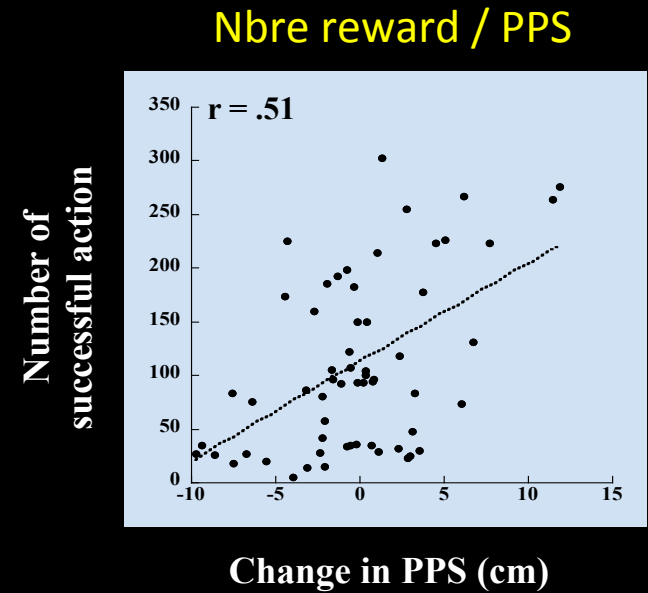


**Reachability
Judgment**

31 targets
4 times
124 trials



PPS depends on not only information about the visual and motor systems, but also on the expected reward of interacting with surrounding objects.

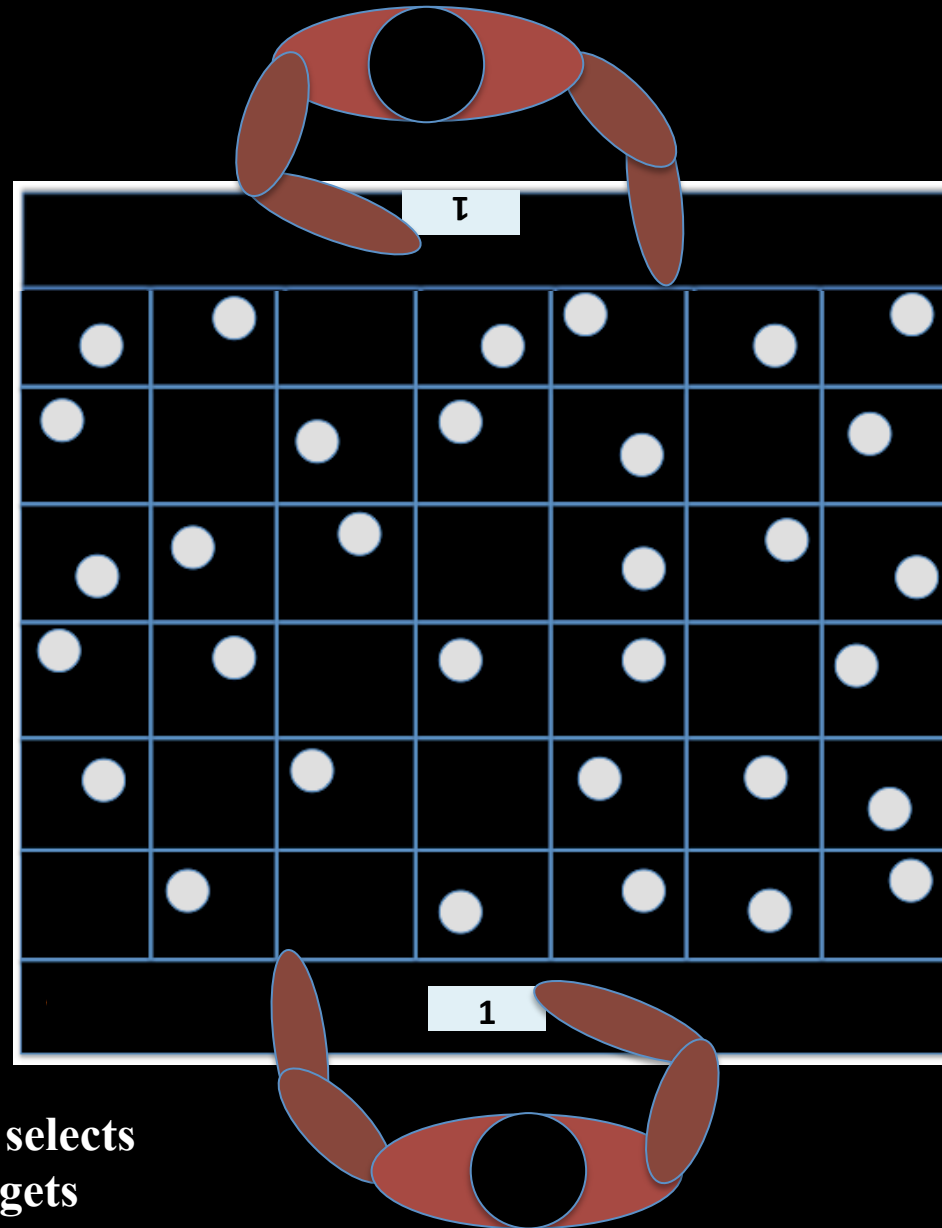


Social context ?

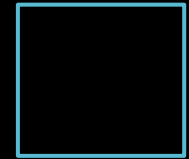


Social condition
Target selection

32 targets
(out of 42 locations)



(x, y) position
Random ± 30 px

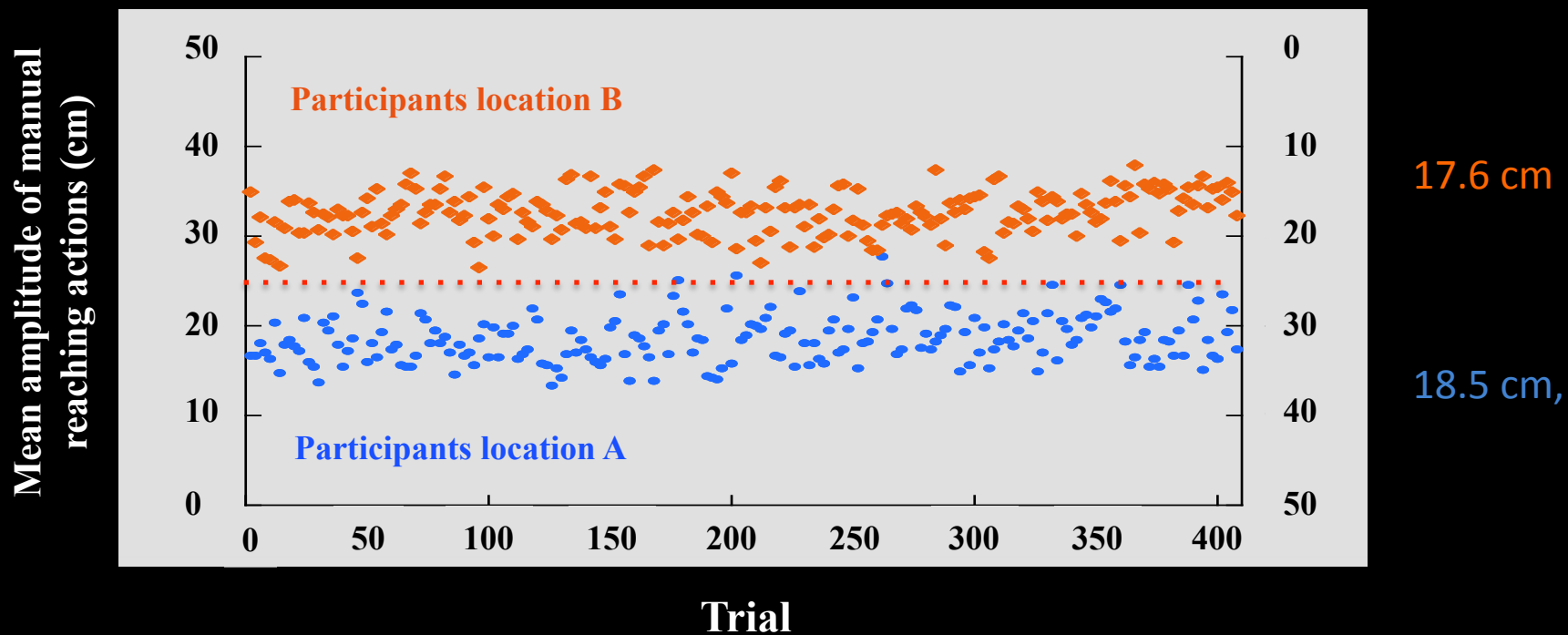
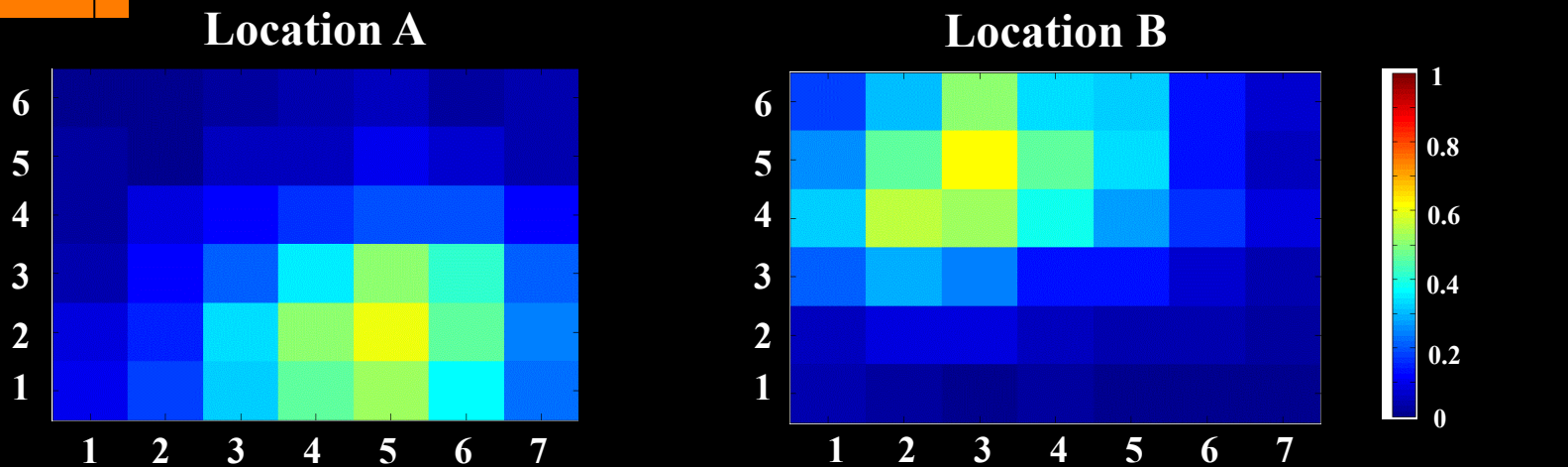


13.8 mm

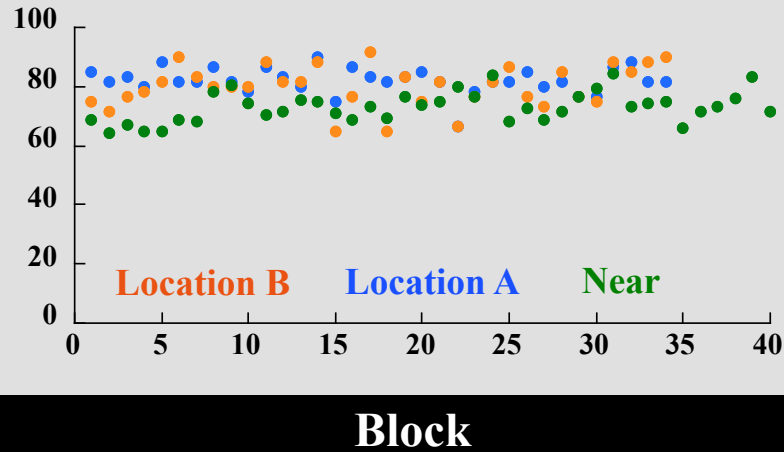
**Task: Each participant selects
alternatively 6 targets
in 34 successive blocks**

Results
Targets selection

Density map

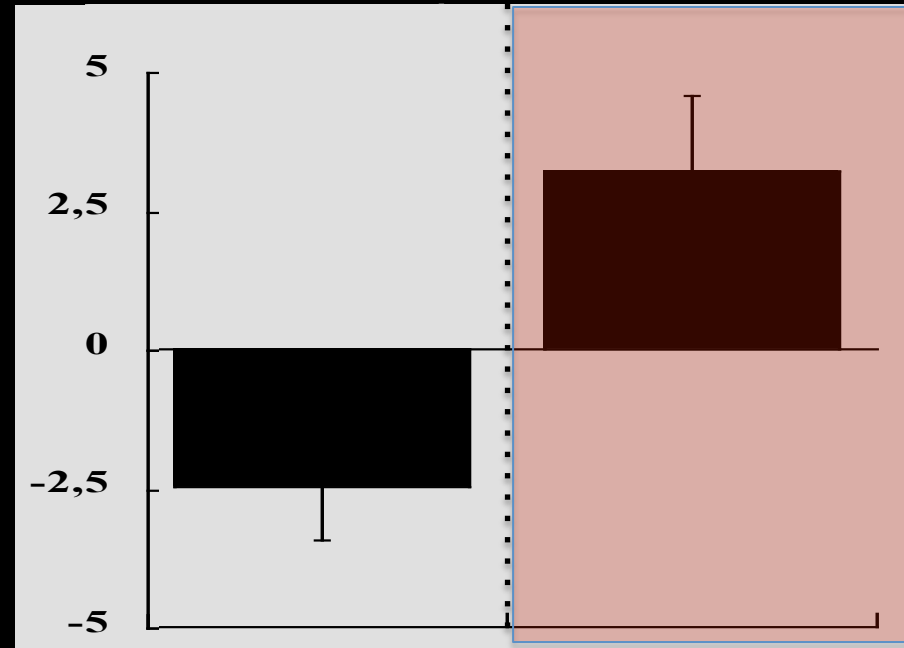


Proximal target selection (%)



Anticipating the consequence of actions carried out by oneself or by others contributes to the representation of PPS

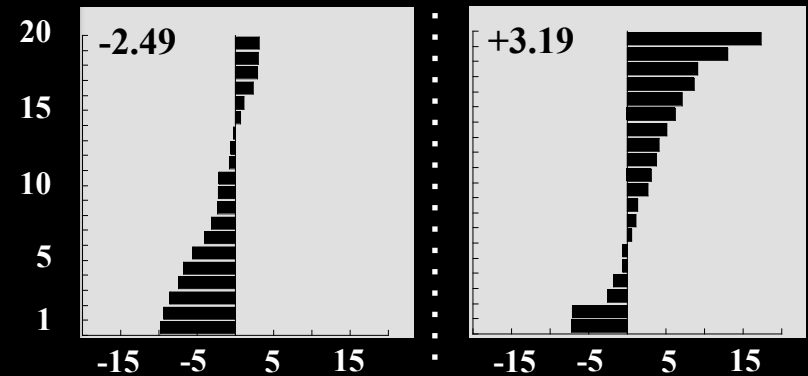
Relative change
Posttest-Pretest (cm)



Individual-Near

Social

Participants



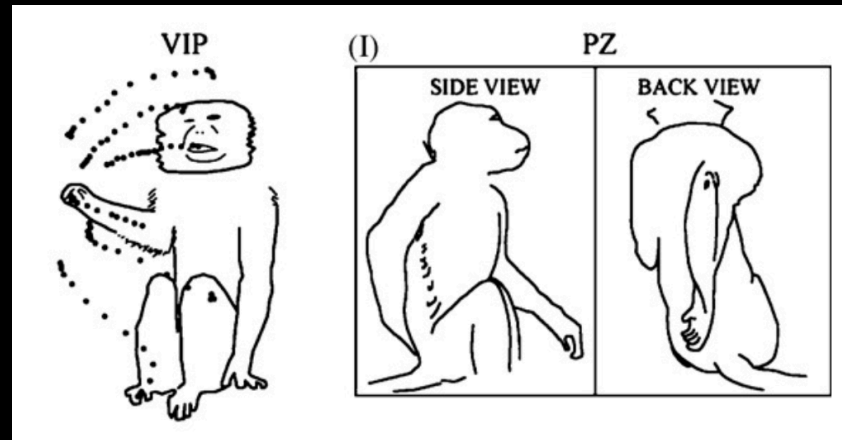
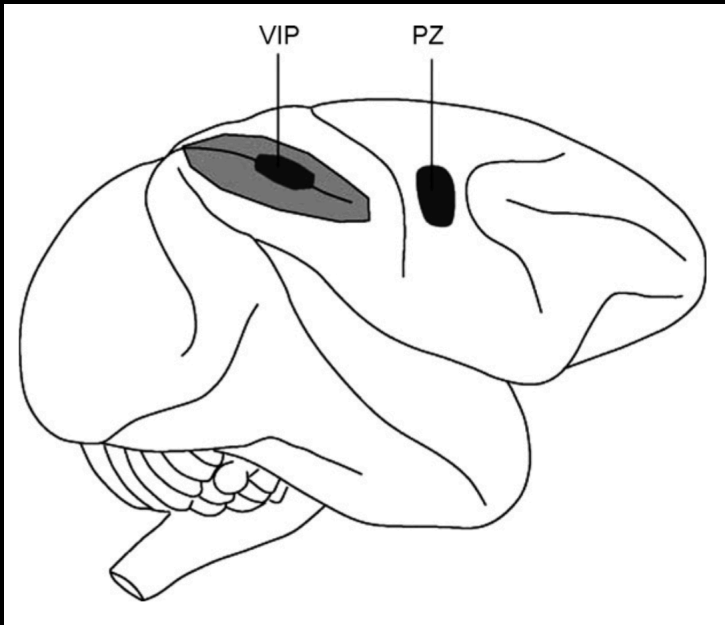
Relative change Posttest-Pretest (cm)

The protective dimension of PPS



PPS space : a space for defensive behaviour to protect the body from threatening stimuli

Defensive actions following electrical stimulation of multisensory regions (VIP-PZ)



Graziano & Cooke (2006)

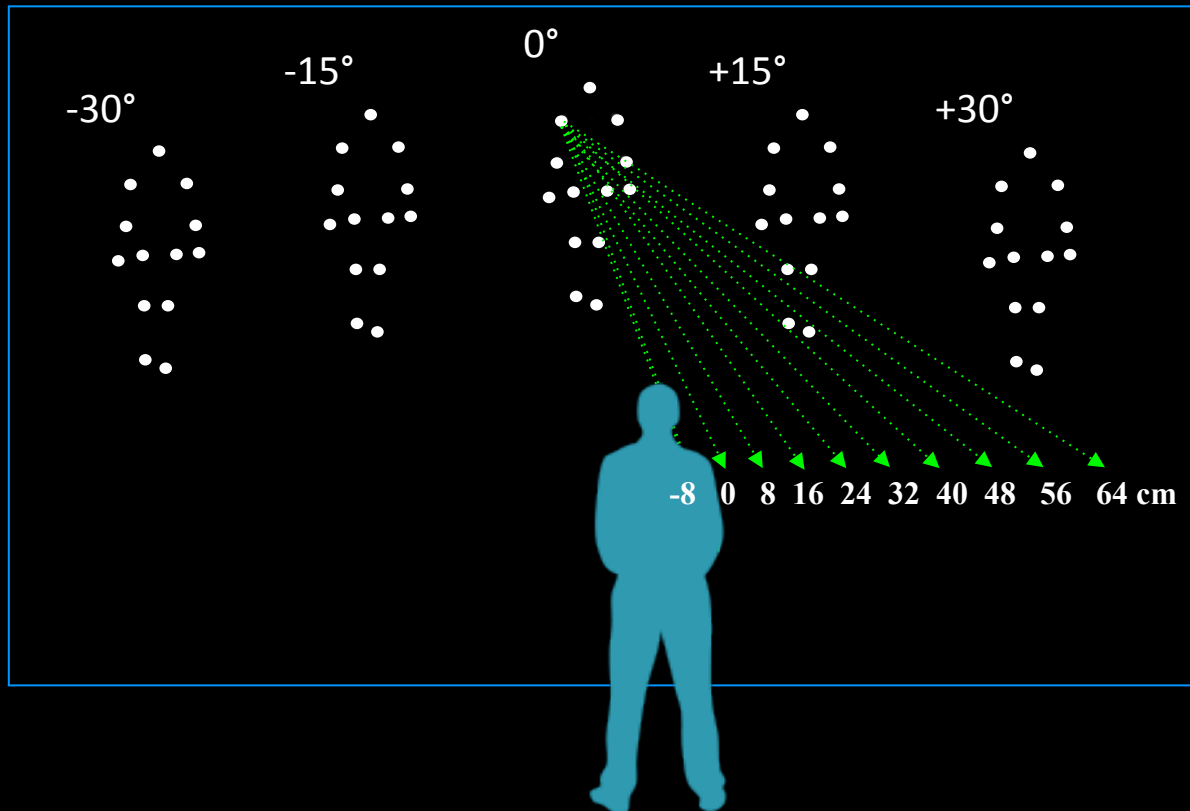


Two complementary functions of PPS:

- goal-directed actions towards non-threatening stimuli
- defensive behaviours against threatening and potentially harmful stimuli



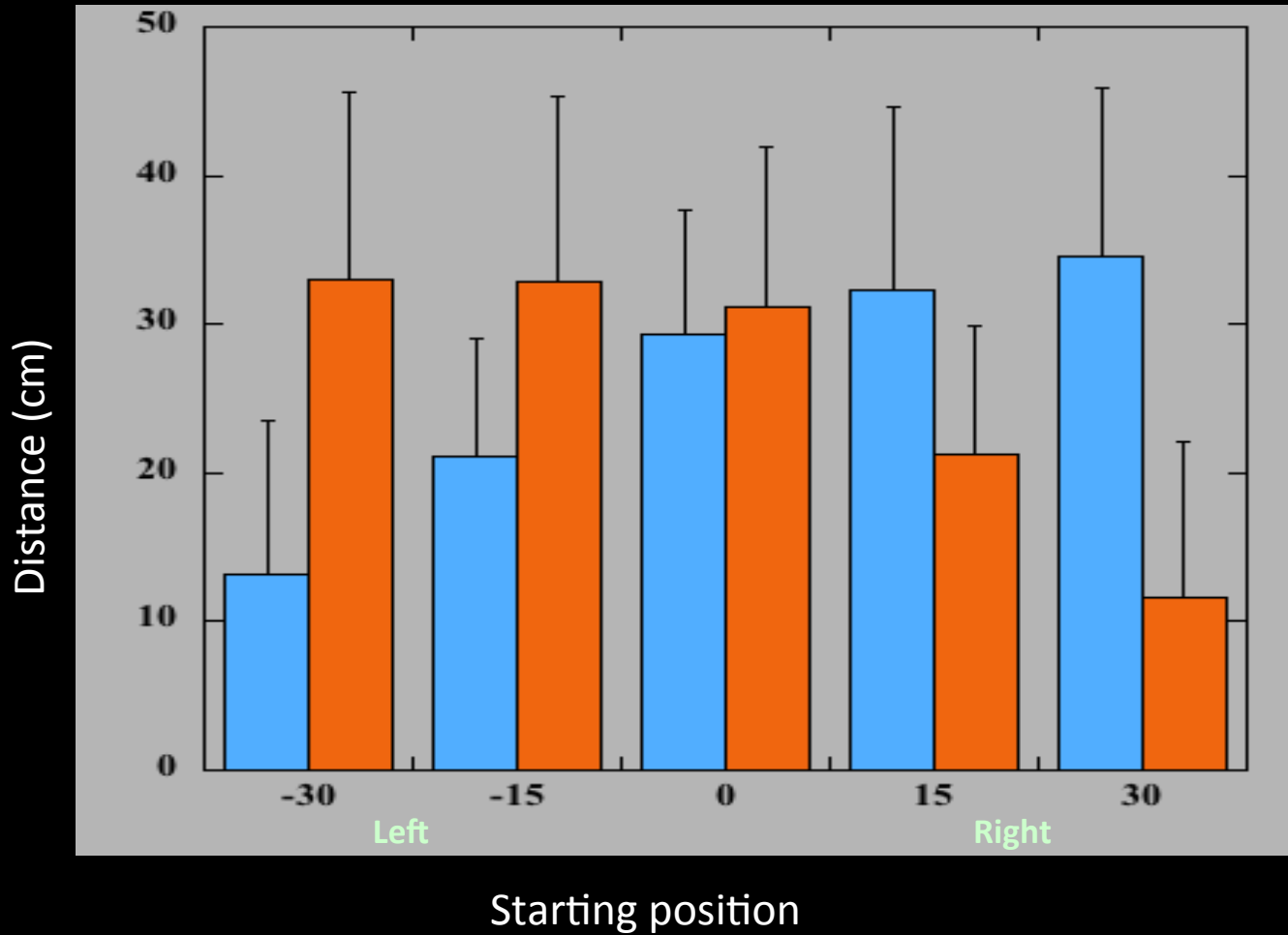
Organisation of the social life

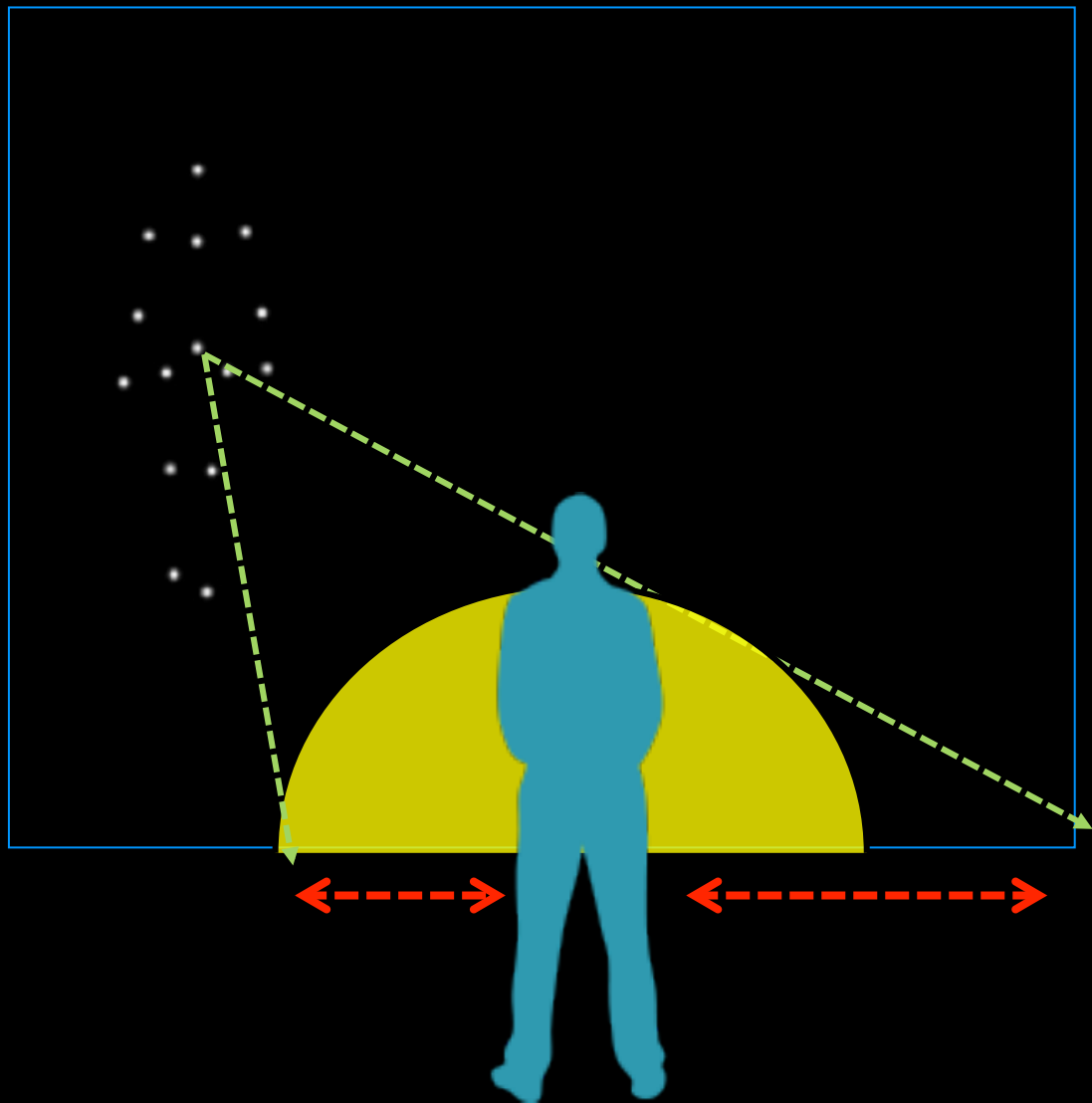


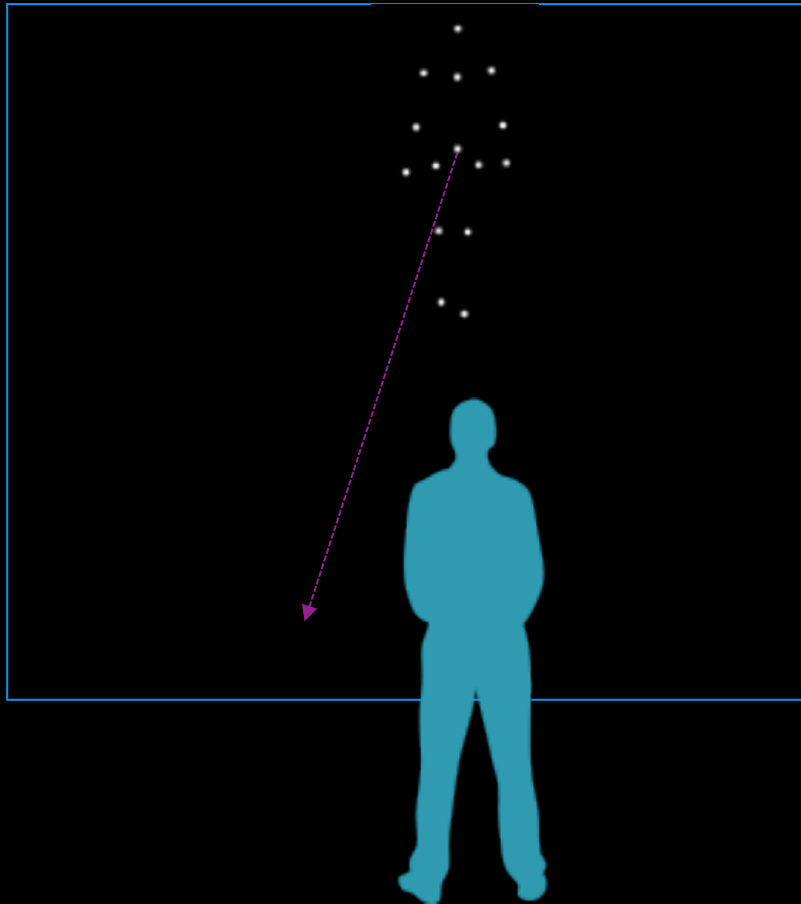
Crosses at a comfortable distance ?

- Passing on the right
- Passing on the left

Distance from shoulder







Pretest / Posttest

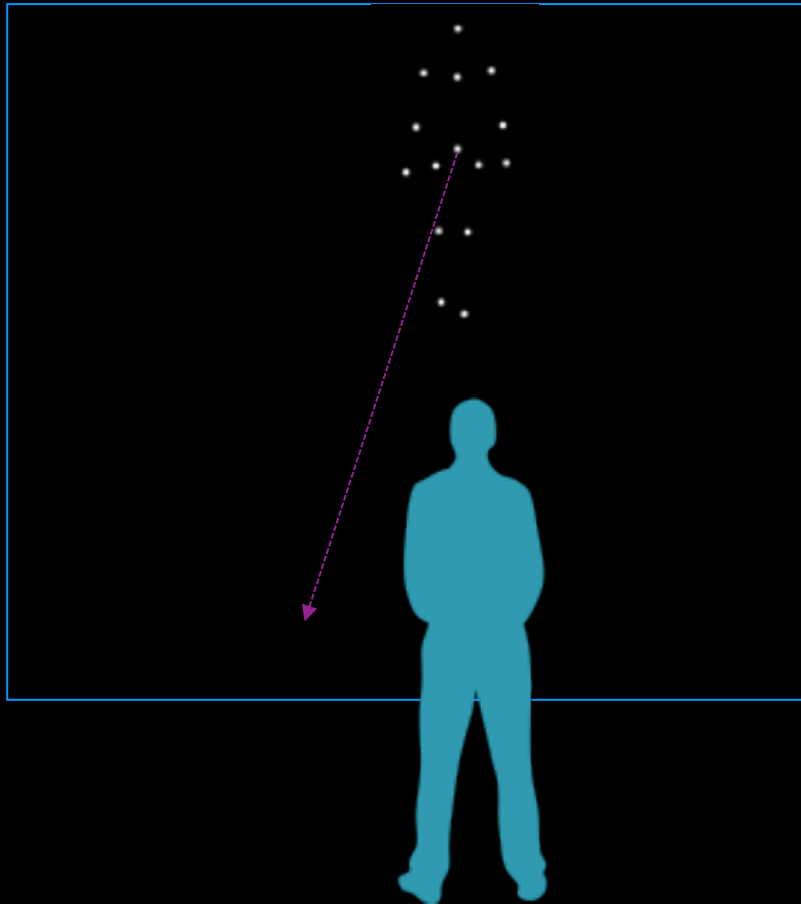


Arm extension in
the body schema

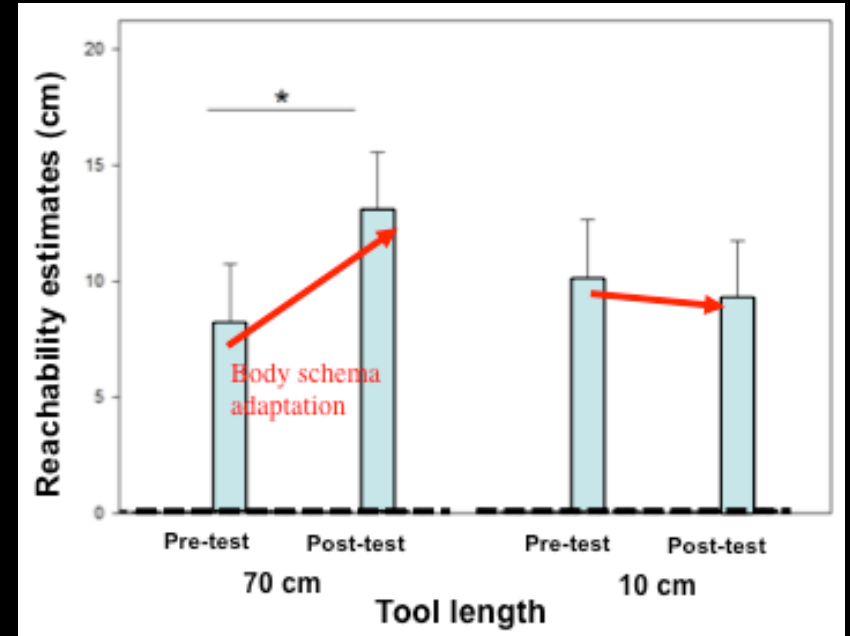
↓
Extension of
peripersonal space

No arm extension
in the body schema

↓
No extension of
peripersonal space



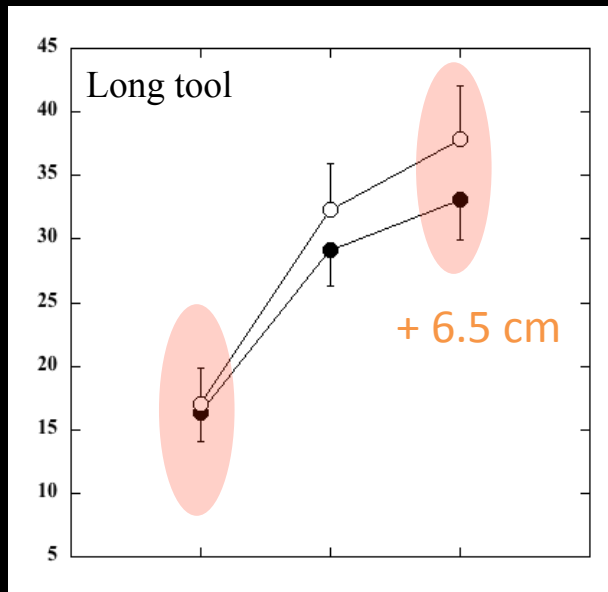
Pretest / Posttest



Peripersonal space representation

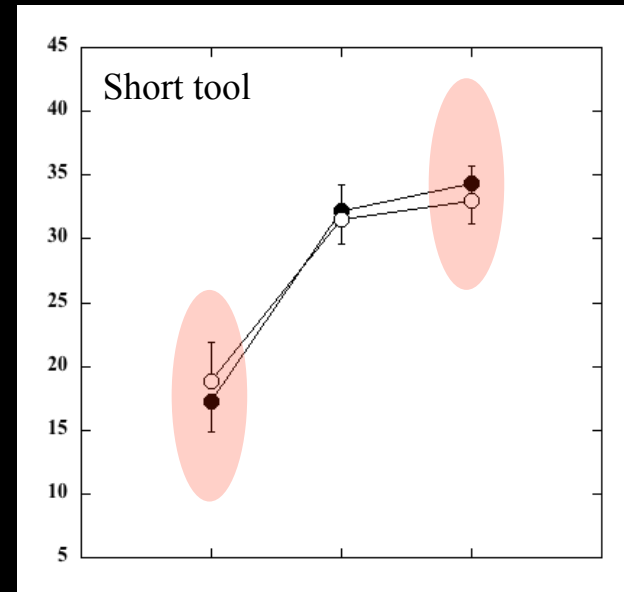
Comfort social distance

Minimum comfort distance (cm)



Not crossing Straight ahead Crossing ahead

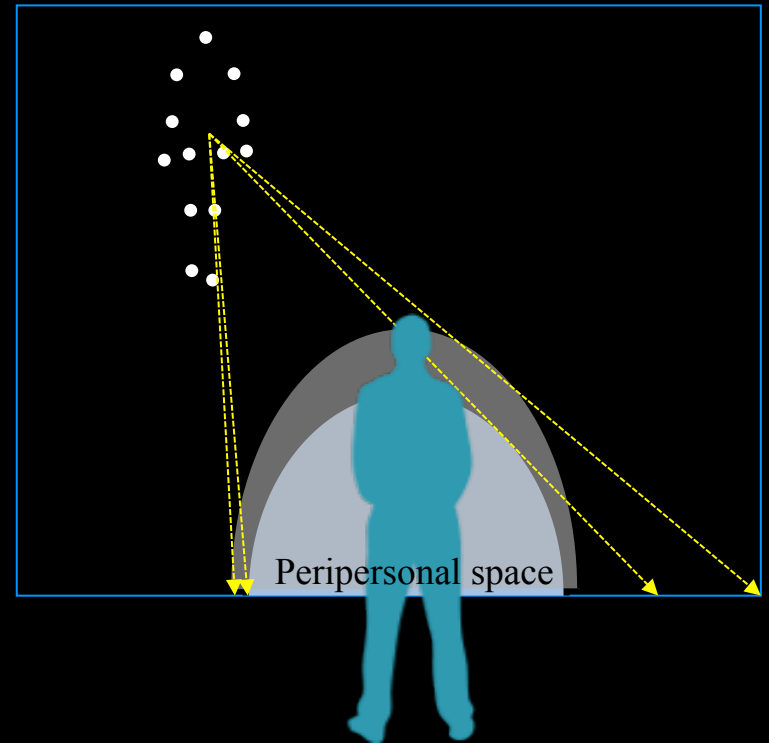
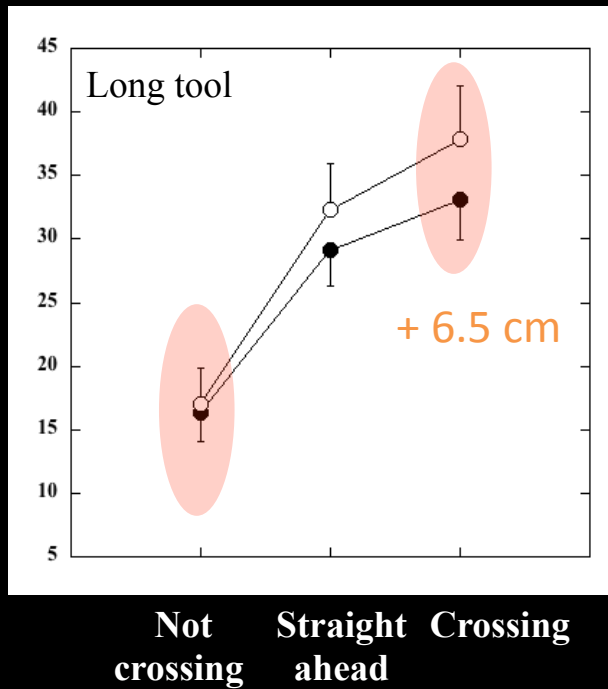
○ Pre-test
● Post-test



Not crossing Straight ahead Crossing ahead

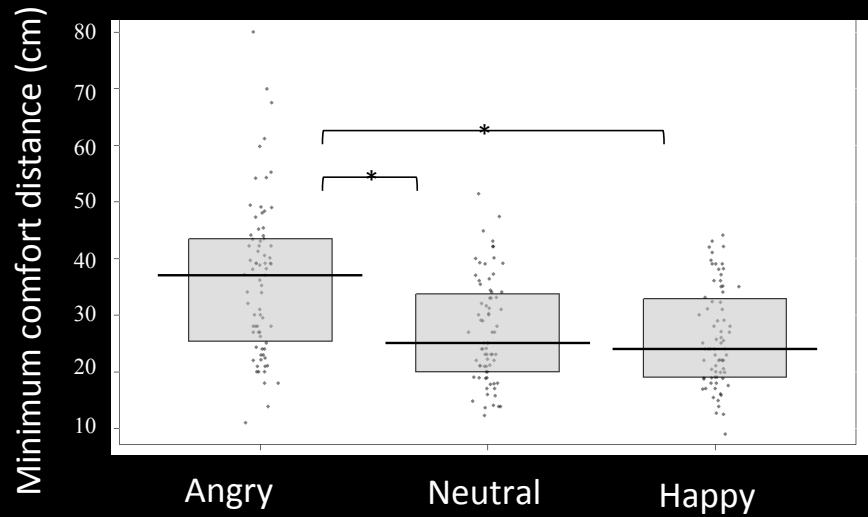
Comfort social distance

Minimum comfort distance (cm)

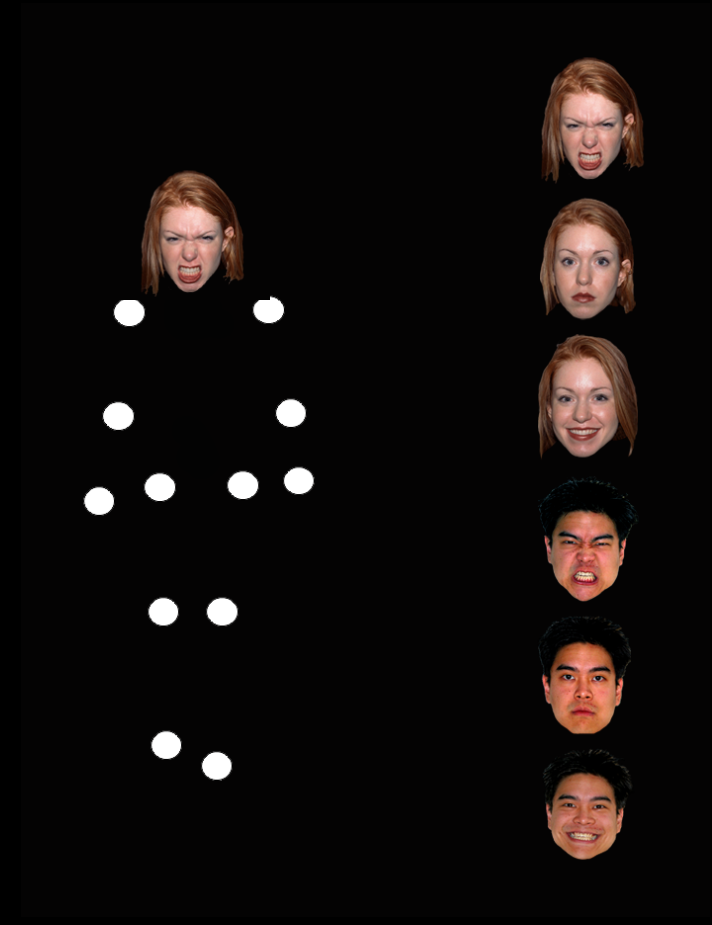
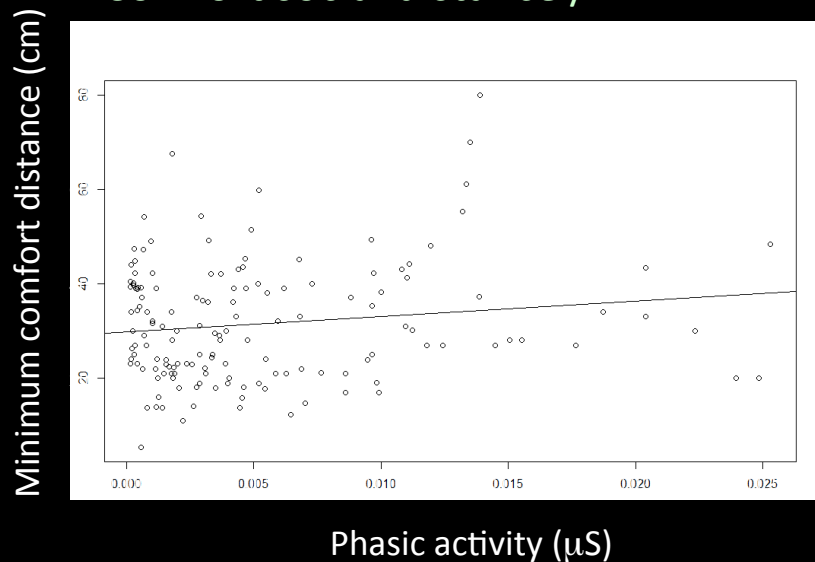


PPS depends thus on the sensorimotor system and the properties of the visual objects, and social distances are spatially determined by the representation of PPS for oneself & others.

Comfort social distance / Emotion

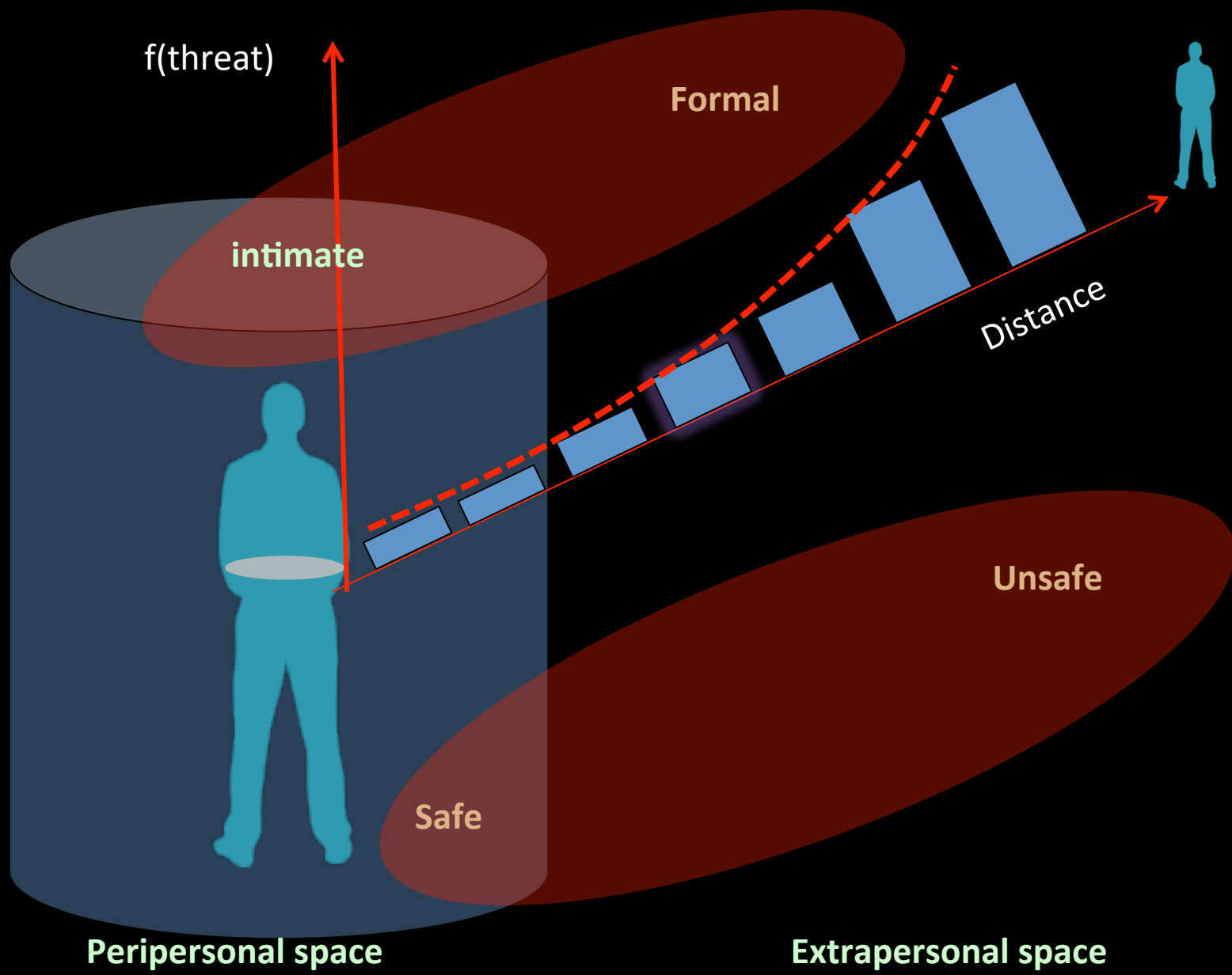


Comfort social distance / EDA



Gain of 5.14 cm (comfort space) /
increase of 0.01 μS phasic activity

Theoretical framework for social interactions



Thank you for your attention !

