Cluster approach for EEG analysis: predicting upcoming sensorimotor event.

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Abraço
Ação NeuroMat para pessoas
com lesão do plexo Braquial

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Prediction investigation

The ability to predict an upcoming action is an **intrinsic property** of the motor system.

Brachial Plexus Injury (BPI) leads to **severe impairment of upper limb function**.
Is it possible that sensory and motor deficits associated with BPI affects prediction?

Would the sensorimotor cortex be able to distinguish between prediction contexts?

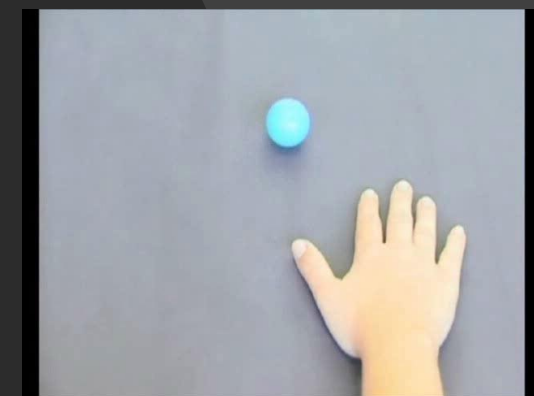*Does BPI affect prediction ability?*

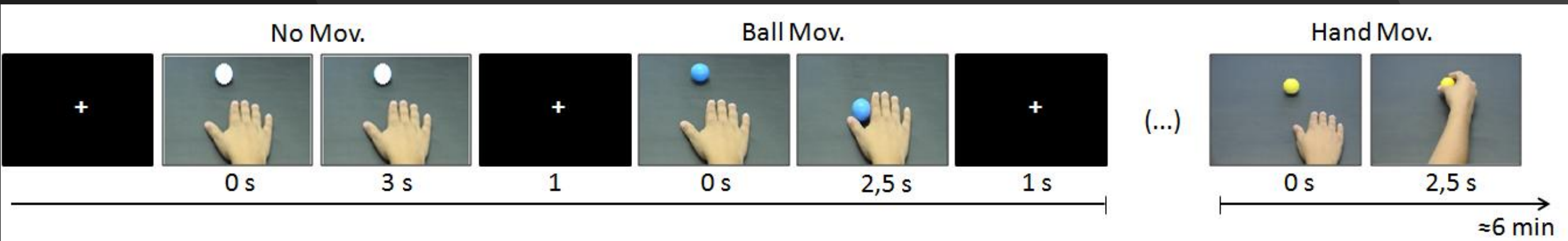# Action observation paradigm

Experimental setup
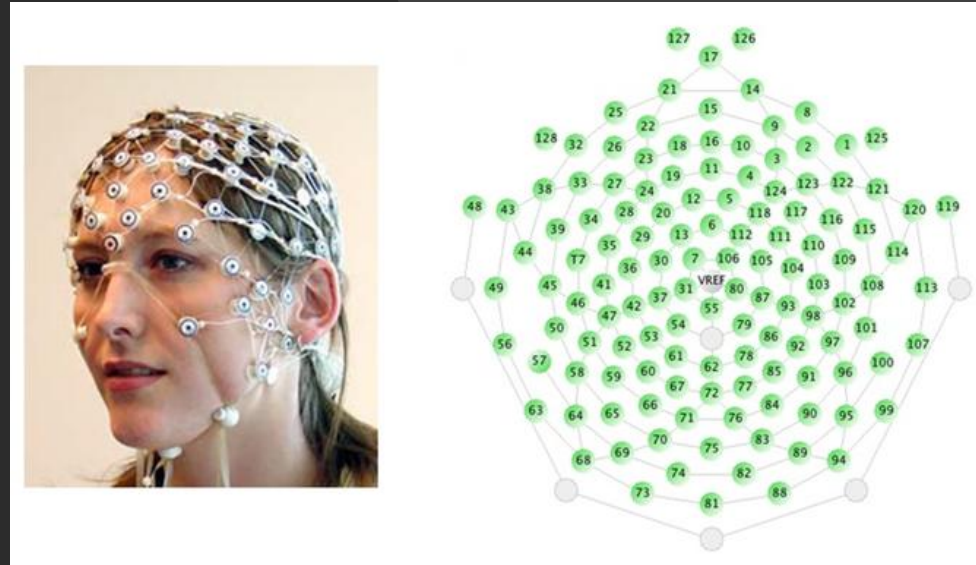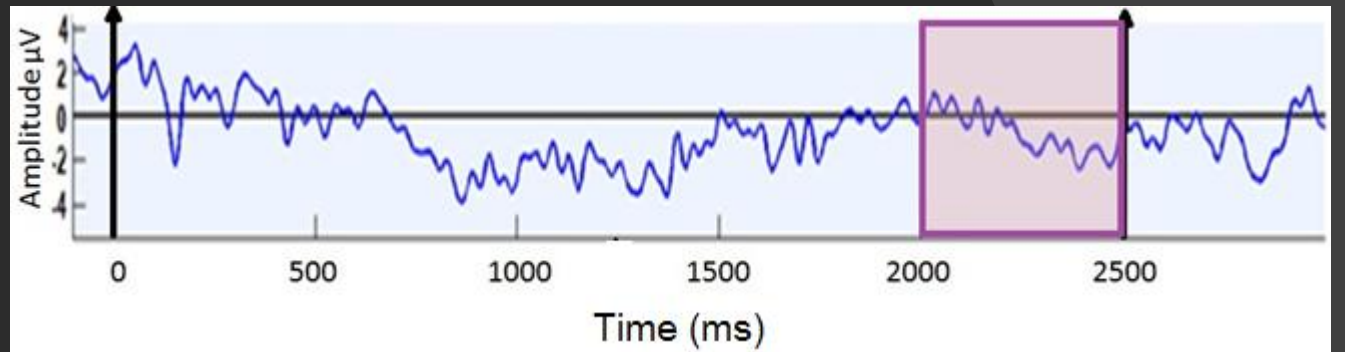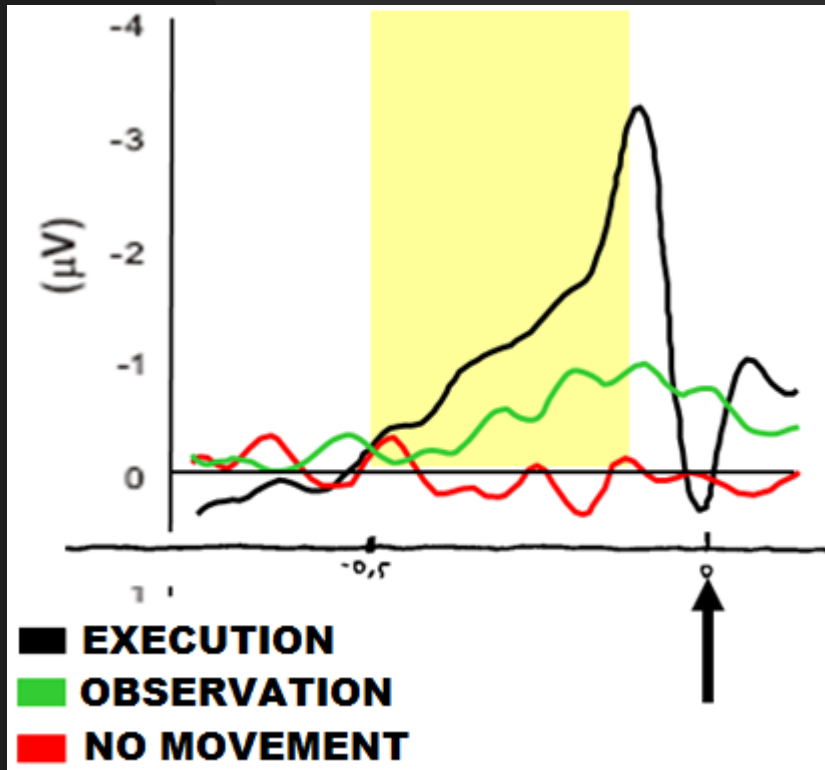

Hand Mov

Ball Mov

No Mov

Protocol

- Duration: ~ 2h
- 6 blocks (3 right hand and 3 left hand)
- 60 trials per block
- Conditions presented at random

Protocol

Readiness Potential – Prediction marker
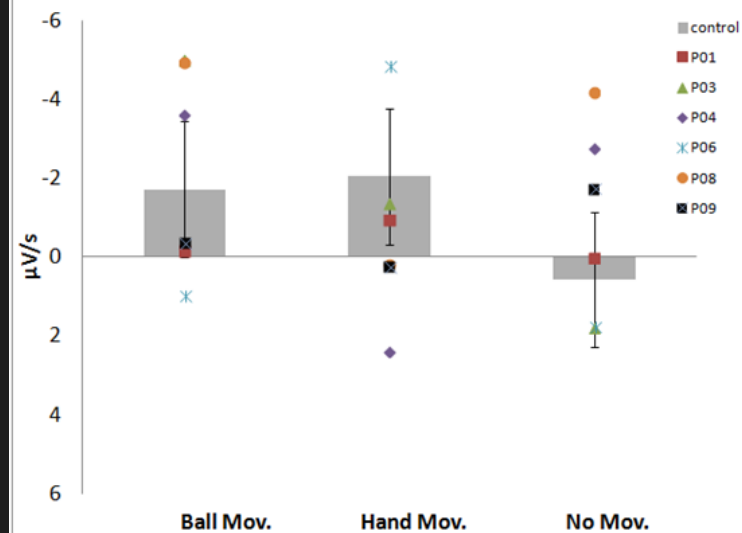(Kilner et al, 2004)

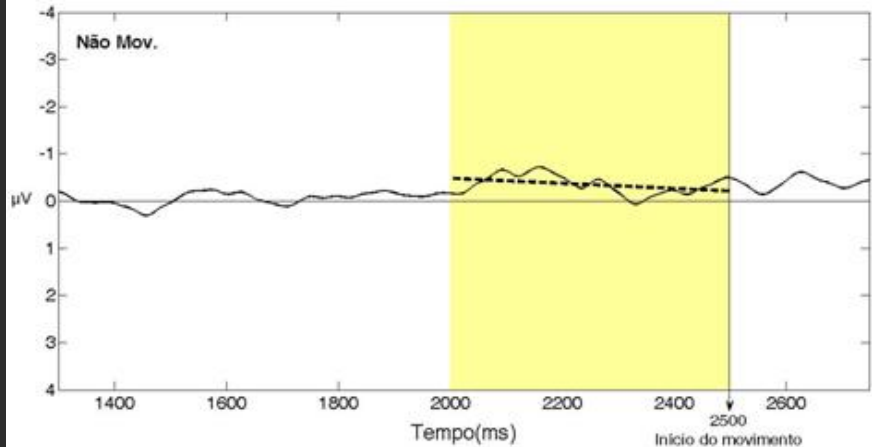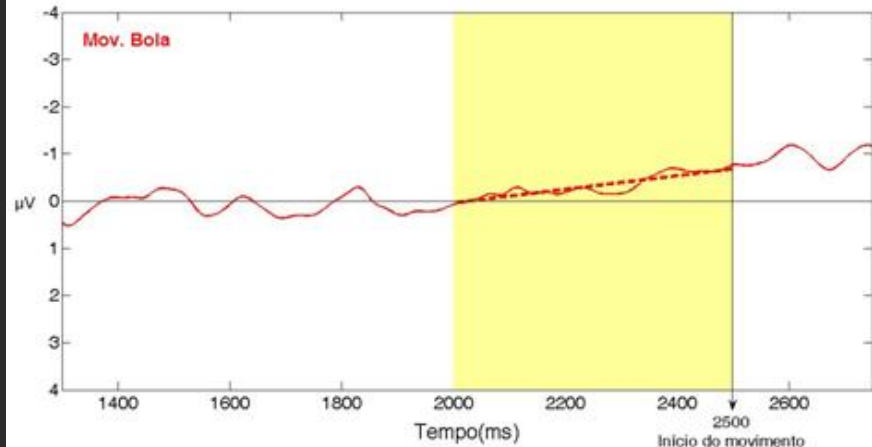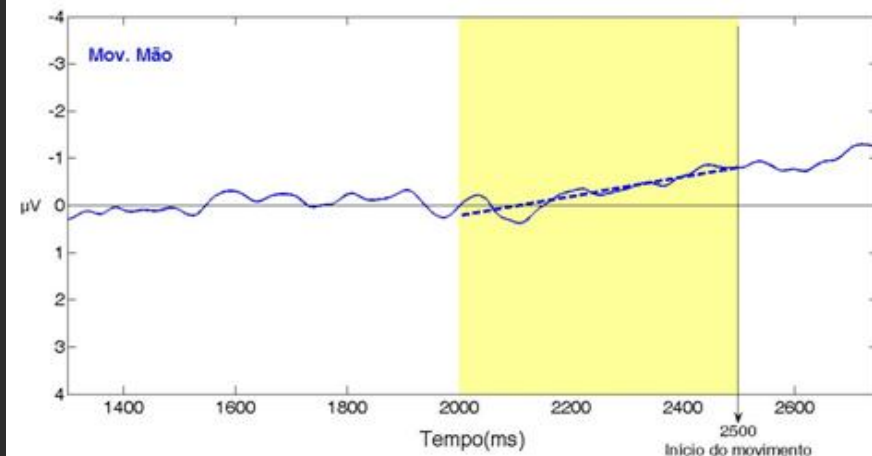Time window - Negative slope
500 ms before movemet beggining

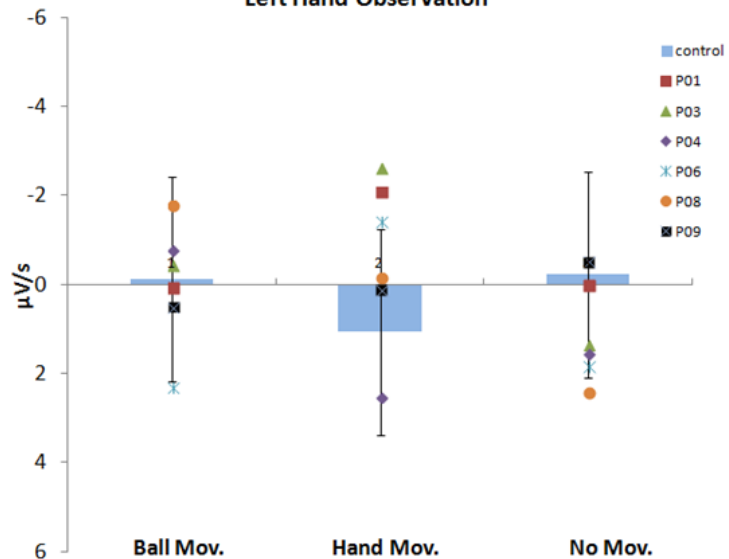# Participants

- **Control Group**

✓18 participants --- 9 included in the analyses after signal examination and pre-processing

  ✓ 7 males, mean age 29,9 years, Right handed

- **Brachial Plexus Injury Group**

✓9 participants, 6 included, all male, mean age 28,6 years, Right Handed

ID	Age	Lesion time	Lesion Side	Handedness	Diagnosis
P01	30	1y 3m	Right	Right	C5 - C7
P03	20	8m	Right	Right	C5 - C6
P04	24	7m	Right	Right	C5 - C7
P06	32	8m	Right	Right	C5 - C7
P08	26	2y	Left	Right	C5 - T1
P09	40	6m	Left	right	C5 - T1

|	Muscular Manual Test					Sensory Test		
	C5	C6	C7	C8	T1	Radial	Median	Ulnar
P01	1	3	0	5	3	4	14	12
P03	3	5	4	5	5	-	-	-
P04	1	4	4	5	4	9	15	18
P06	1	4	5	4	4	9	5	15
P08	2	0	1	0	0	0	0	0
P09	0	0	0	0	0	0	0	4

Classical Readiness Potential

3 steps

1)K-means cluster analysis
2)Fisher exact-test
3)Multi-subject analysis

Data preparation

For each subject we consider two sets of electrodes: 8 electrodes in the sensorimotor cortex (in red), and 8 control electrodes over temporal cortex (in blue).
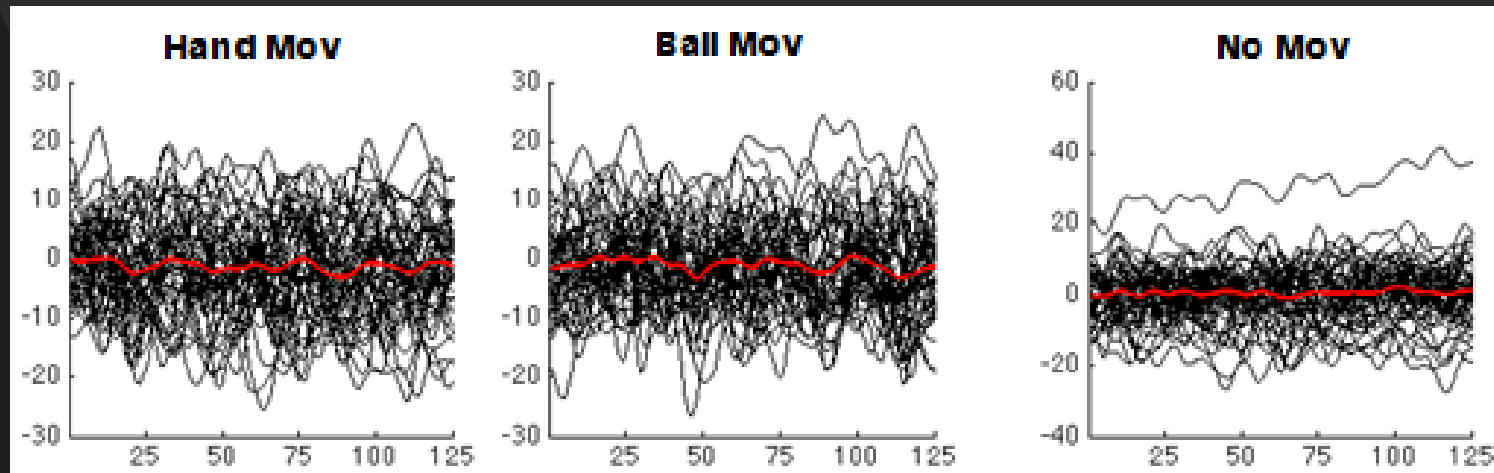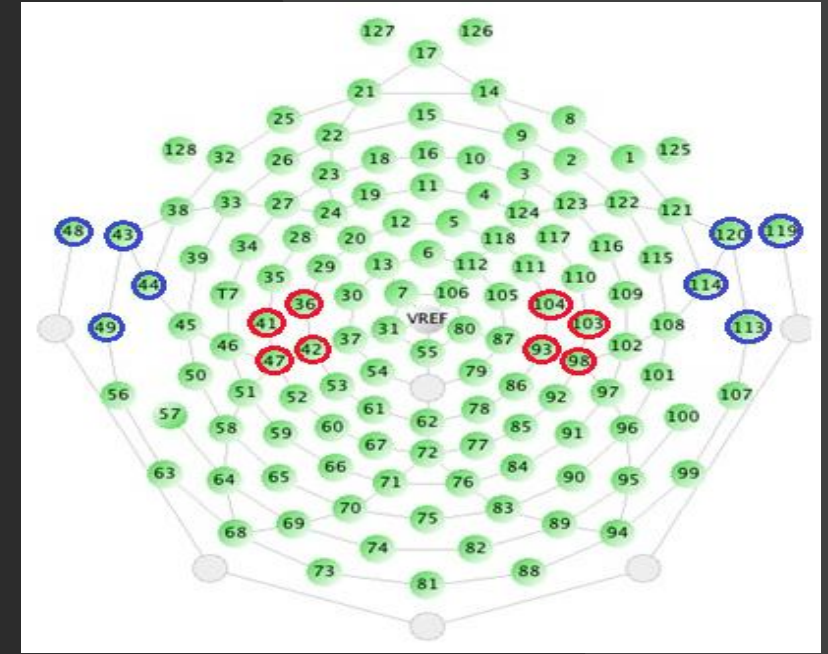
For each subject and each electrode (ex. CP3) we compute the average signal across epochs for each experimental condition

Data preparation

Second, we consider the 12 averaged signals, obtained from the three experimental conditions for all 4 electrodes of the sensorimotor cortex
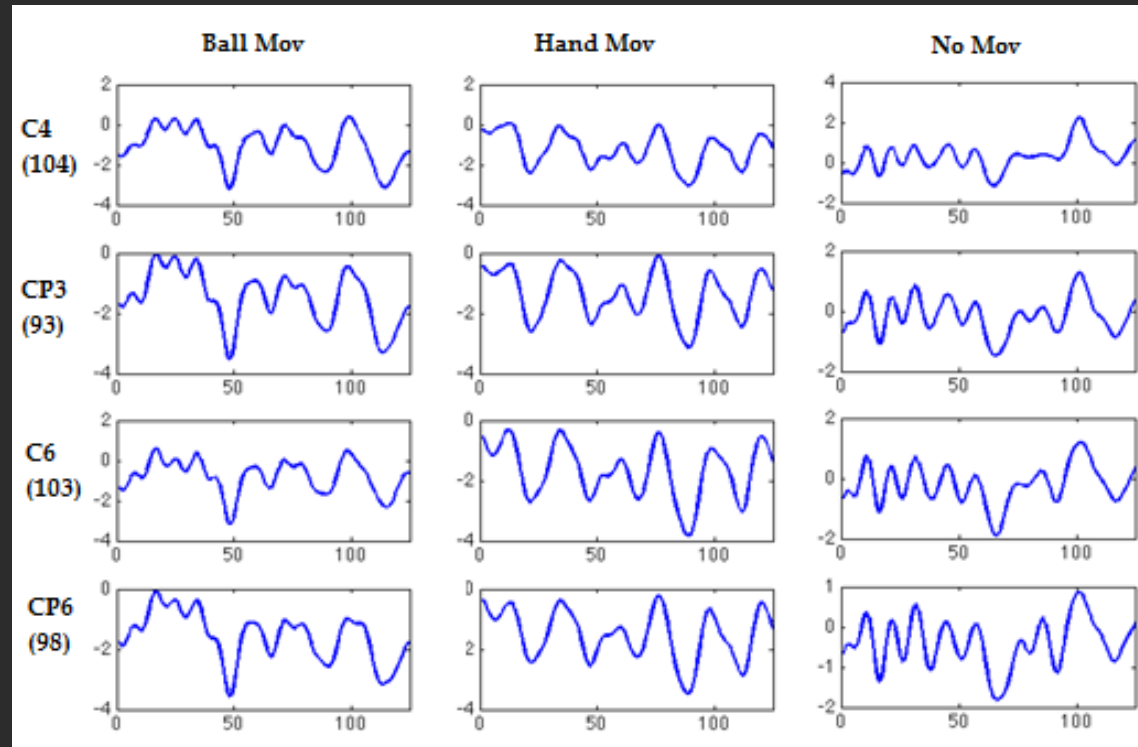
For each subject, the 12 averaged signals for the electrodes in the sensorimotor cortex and the control electrodes were submitted to an hierarchical analysis, the first step was a k-means cluster analysis.

1) K-means cluster analyses
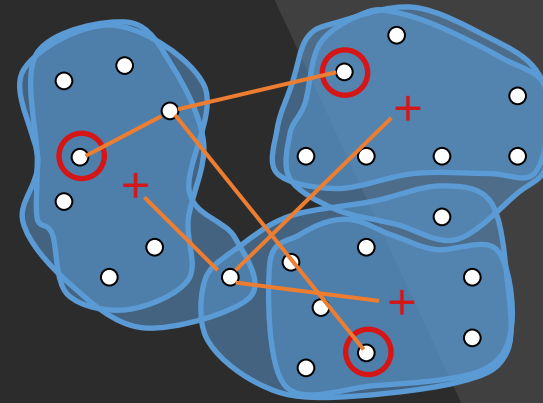
2ª Iteração

For each subject and set of electrodes, the goal was to group the 12 curves (3 conditions x 4 electrodes) into 3 possible clusters: A, B or C.

If the signal in the sensorimotor cortex is different between conditions, **the signals from the same condition should belong to the same cluster**, with a high separation between the clusters.

Our hypothesis is that we are able to observe this separation between conditions in the sensorimotor cortex but not in the set of temporal electrodes

K-means cluster analyses

Illustration of how the k-means cluster assigns a label to each one of the 12 averaged signals

Signal	1	2	3	4	5	6	7	8	9	10	11	12
Cluster	A	A	A	A	B	B	B	B	C	C	C	C

After the k-means step, we have a contingency table for each subject and for both sets of electrodes.

	Cluster A	Cluster B	Cluster C
Hand Mov	4	0	0
Ball Mov	0	4	0

Intuitively, we can say that if the signals in 2 different conditions belong to the same cluster, we have an indication that the brain is not recognizing the conditions as distinct from each other.

2) **Fisher exact-test**

H0: The cluster label is independent of the experimental condition

H1: The cluster label is not independent of the experimental condition

Is there a strong dependence between condition and cluster label?

3) Multi-subject analysis

✓ The Fisher's exact test is performed for each subject independently. Therefore, 12 tests are performed.

✓ The Benjamini–Hochberg procedure was performed for correcting the p-value and controlling the false positive rate in multiple comparisons.

Results

Control Group (N=9)

Right Hand Observation

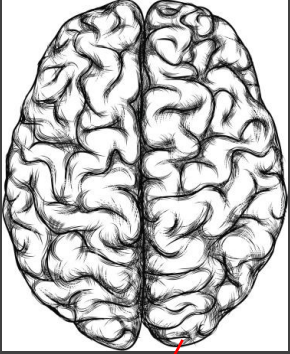| Condition comparison	Sensorimotor cortex electrodes		Temporal cortex electrodes (control)	
	Right Hemisphere	Left Hemisphere	Right Hemisphere	Left Hemisphere
Ball Mov x No Mov	9	7	0	0
Hand Mov x No Mov	8	8	0	0
Hand Mov x Ball Mov	7	8	0	0
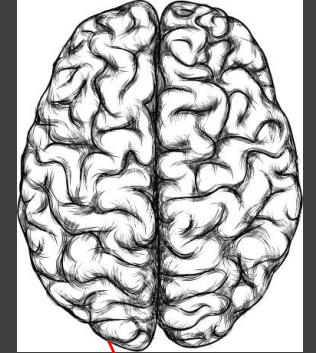
The table indicates the number of subjects that rejected H0

Results

Control Group (N=9)

Left Hand Observation

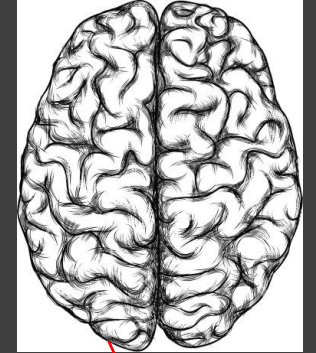| Condition comparison	Sensorimotor cortex electrodes		Temporal cortex electrodes (control)	
	Right Hemisphere	Left Hemisphere	Right Hemisphere	Left Hemisphere
Ball Mov x No Mov	9	9	0	0
Hand Mov x No Mov	8	8	0	0
Hand Mov x Ball Mov	9	6	0	0

The table indicates the number of subjects that rejected H0

Results

Brachial plexus Injury(N=6) –

Right Hand Observation

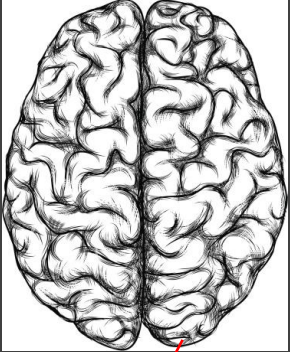| Condition comparison	Sensorimotor cortex electrodes		Temporal cortex electrodes (control)	
	Right Hemisphere	Left Hemisphere	Right Hemisphere	Left Hemisphere
Ball Mov x No Mov	4	0	0	0
Hand Mov x No Mov	0	4	0	0
Hand Mov x Ball Mov	0	5	0	0

The table indicates the number of subjects that rejected   H0

Results

Brachial plexus Injury(N=6)

Left Hand Observation

Condition comparison	Sensorimotor cortex electrodes		Temporal cortex electrodes (control)	
	Right Hemisphere	Left Hemisphere	Right Hemisphere	Left Hemisphere
Ball Mov x No Mov	4	5	0	0
Hand Mov x No Mov	0	0	0	0
Hand Mov x Ball Mov	0	0	0	0

The table indicates the number of subjects that rejected   H0