

# Default Mode Network identification with Electroencephalography

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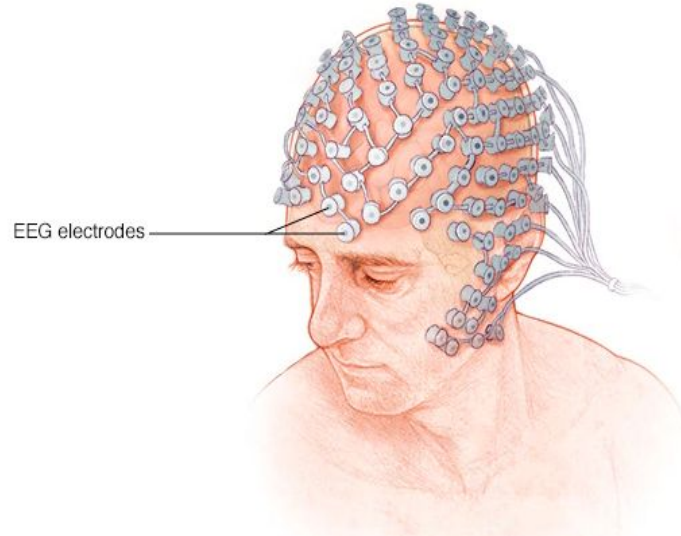
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# Electroencephalography (EEG)

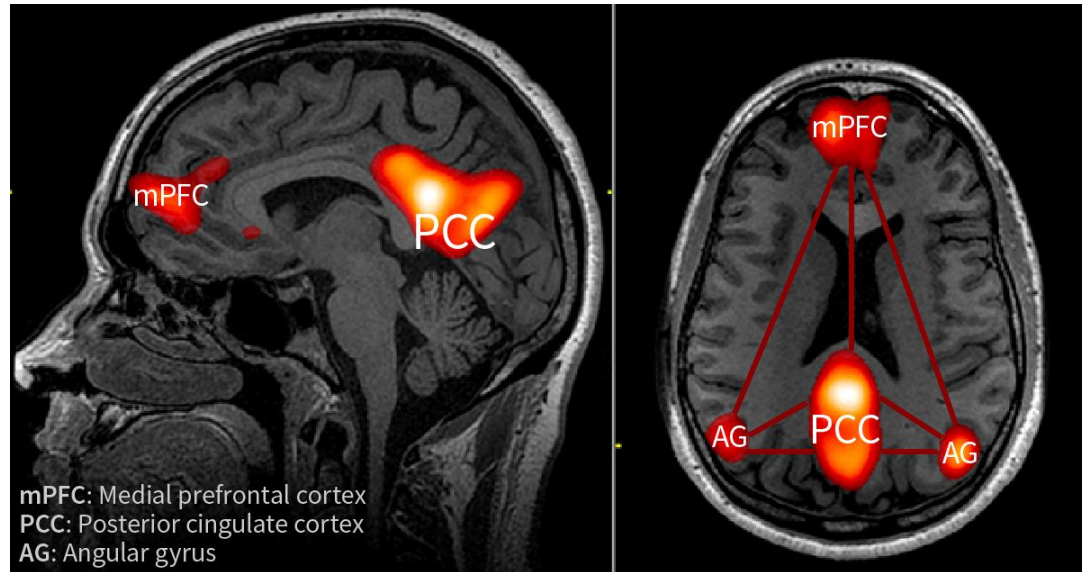
Electroencephalography (EEG) is an electrophysiological monitoring method to record electrical activity of the brain.

EEG measures voltage fluctuations resulting from ionic current within the neurons of the brain.



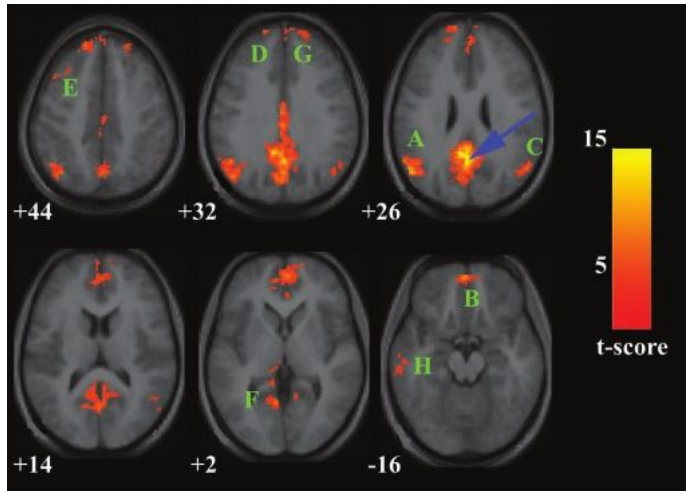
# Default Mode Network (DMN)

DMN is most commonly active when a person is not focused on the outside world and the brain is at wakeful rest, such as during daydreaming and mind-wandering.



[https://en.wikipedia.org/wiki/Default\\_mode\\_network](https://en.wikipedia.org/wiki/Default_mode_network)

# Identification of DMN with fMRI



Michael D. Greicius , Ben Krasnow, Allan L. Reiss, and Vinod Menon  
"Functional connectivity in the resting brain: A network analysis of the default mode hypothesis"

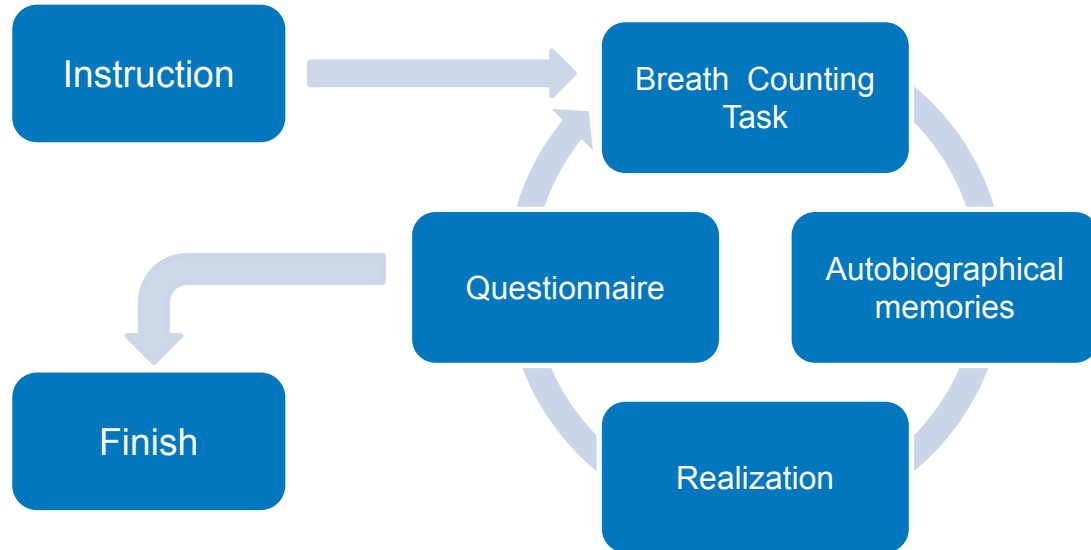
Map of the resting-state neural connectivity.

- With fMRI or PET ,we can easily identify DMN
- There are limited patients that we can examine with fMRI or PET
- The blue arrow indicates the approximate location of the PCC peak
- A and C are approximate location of Angular Gyrus
- D and G shows the location of mPFC.

# Objective

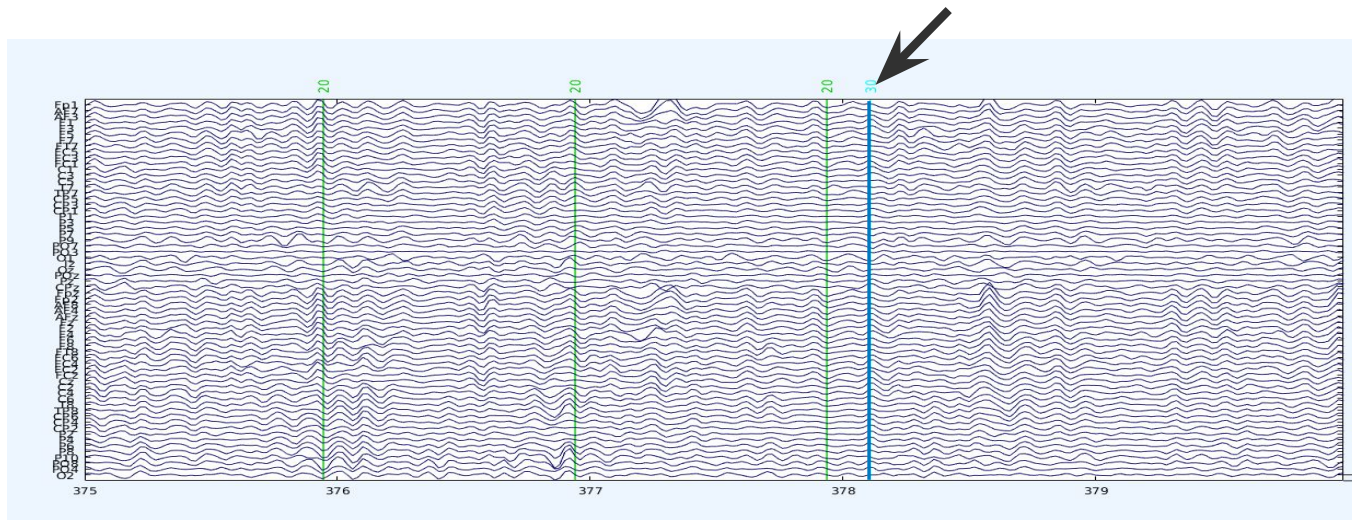
- show that the DMN can also be identified by electroencephalography (EEG)
- Induce a DMN pattern consistent with the pattern observed with PET and fMRI, by using resting-state EEG data.
- **Advantages over fMRI analysis :**
  - Portable,cheap and a wider range of patients can be observed.

# Experimental procedure of Data Collection



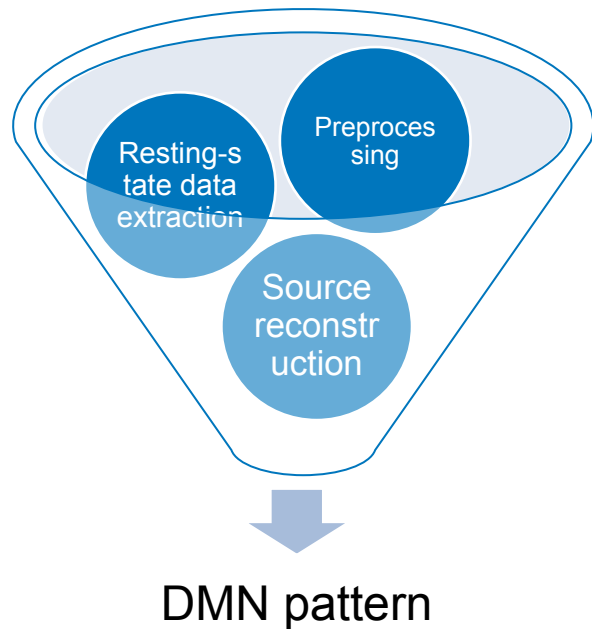
# Data set

- Data set have 64 channels
- sampling rate 1024 Hz
- The black arrow shows the time stamp when subject realized that he/she lost.





# Data analysis



## Steps of data analysis

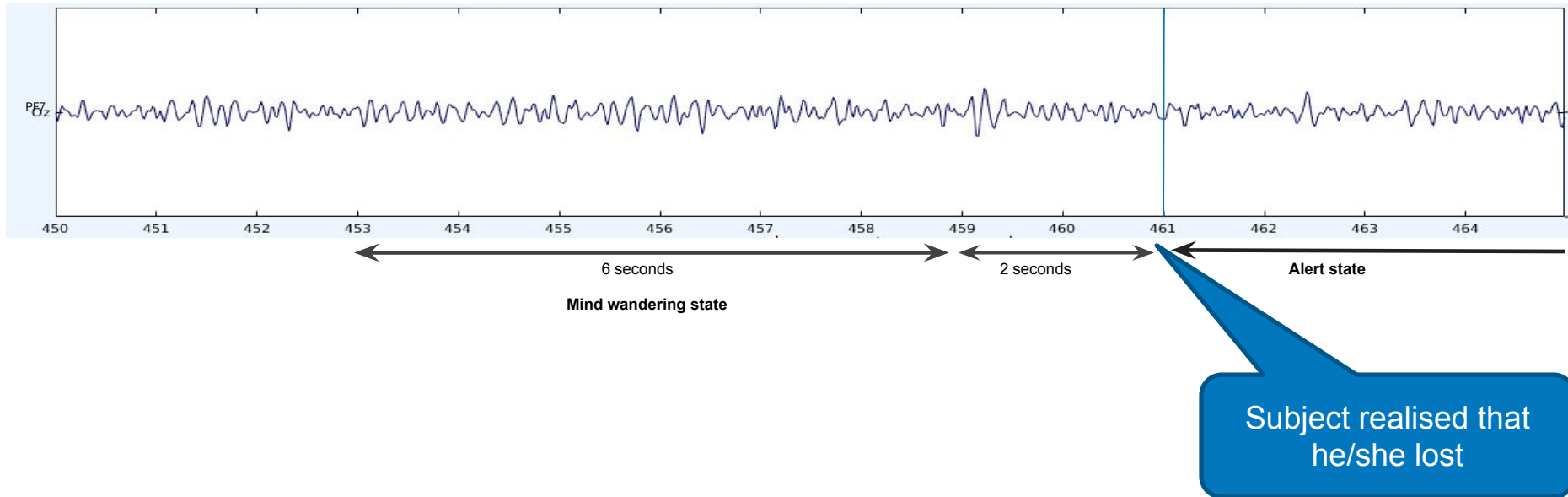
- Preprocessing data
  - Downsampling data
  - Garbage channel rejection
  - Band Pass filtering (4-16 hz)
- Mind wandering data extraction
- Source reconstruction



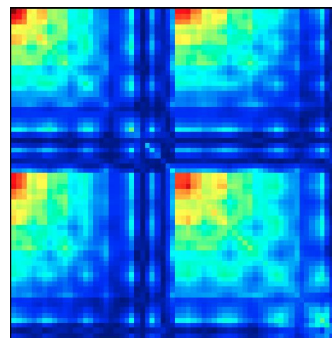
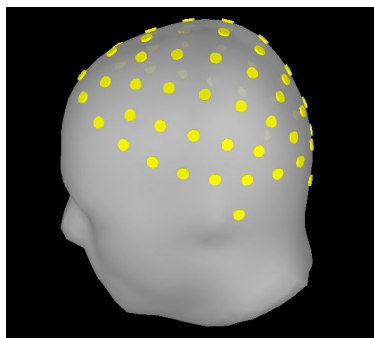
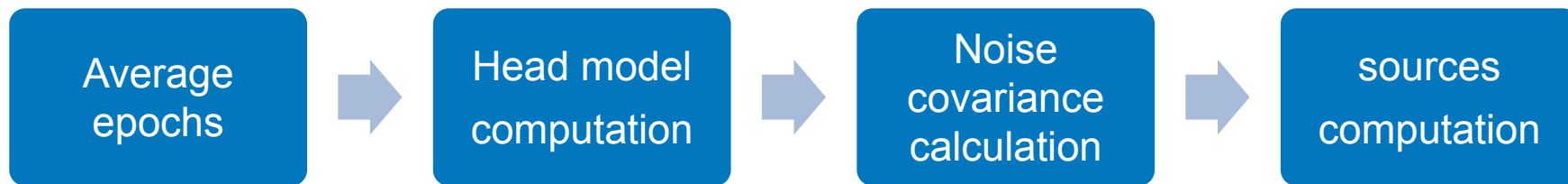
# Preprocessing

- Down-sampling
  - Sampling rate of original data was 1024 Hz
  - Very difficult to process this much of data further
  - Re sampled to 256 Hz
- Band Pass filtering
  - By comparing source activation levels, we found a pattern in  $\theta$  and  $\alpha$  band power changes in PCC, mPFC and AG that is highly consistent with the DMN.
  - we are focusing on the  $\theta$  -band (3.5Hz-7Hz) and  $\alpha$  -band (8-14 Hz)

# Mind wandering data extraction



# Source reconstruction



# Source reconstruction continue ...

## Averaging Epochs :

CH1	$E_{1,1}$	$E_{1,2}$	$E_{1,3}$	$E_{1,4}$	$E_{1,4}$	.....	$E_{1,30}$
CH2	$E_{2,1}$	$E_{2,2}$	$E_{2,3}$	$E_{2,4}$	$E_{2,4}$	.....	$E_{2,30}$
CH3	$E_{3,1}$	$E_{3,2}$	$E_{3,3}$	$E_{3,4}$	$E_{3,4}$	.....	$E_{3,30}$
...	...	...	....	....	....		...
...	...	...	....	....	....		...
CH64	$E_{64,1}$	$E_{64,2}$	$E_{64,3}$	$E_{64,4}$	$E_{64,4}$	.....	$E_{64,30}$

$$E_{1,av} = (E_{1,1} + \dots + E_{1,30})/30$$

$$E_{2,av} = (E_{2,1} + \dots + E_{2,30})/30$$

$$E_{3,av} = (E_{3,1} + \dots + E_{3,30})/30$$

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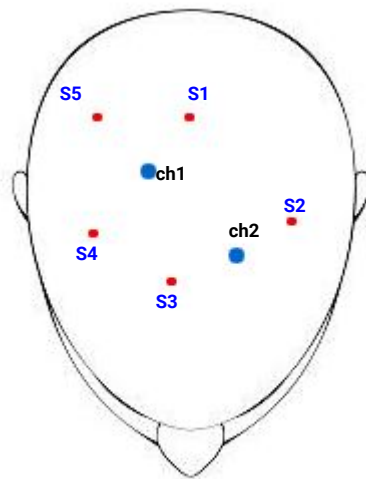
$$E_{64,av} = (E_{64,1} + \dots + E_{64,30})/30$$

# Source reconstruction continue ...

## Noise covariance

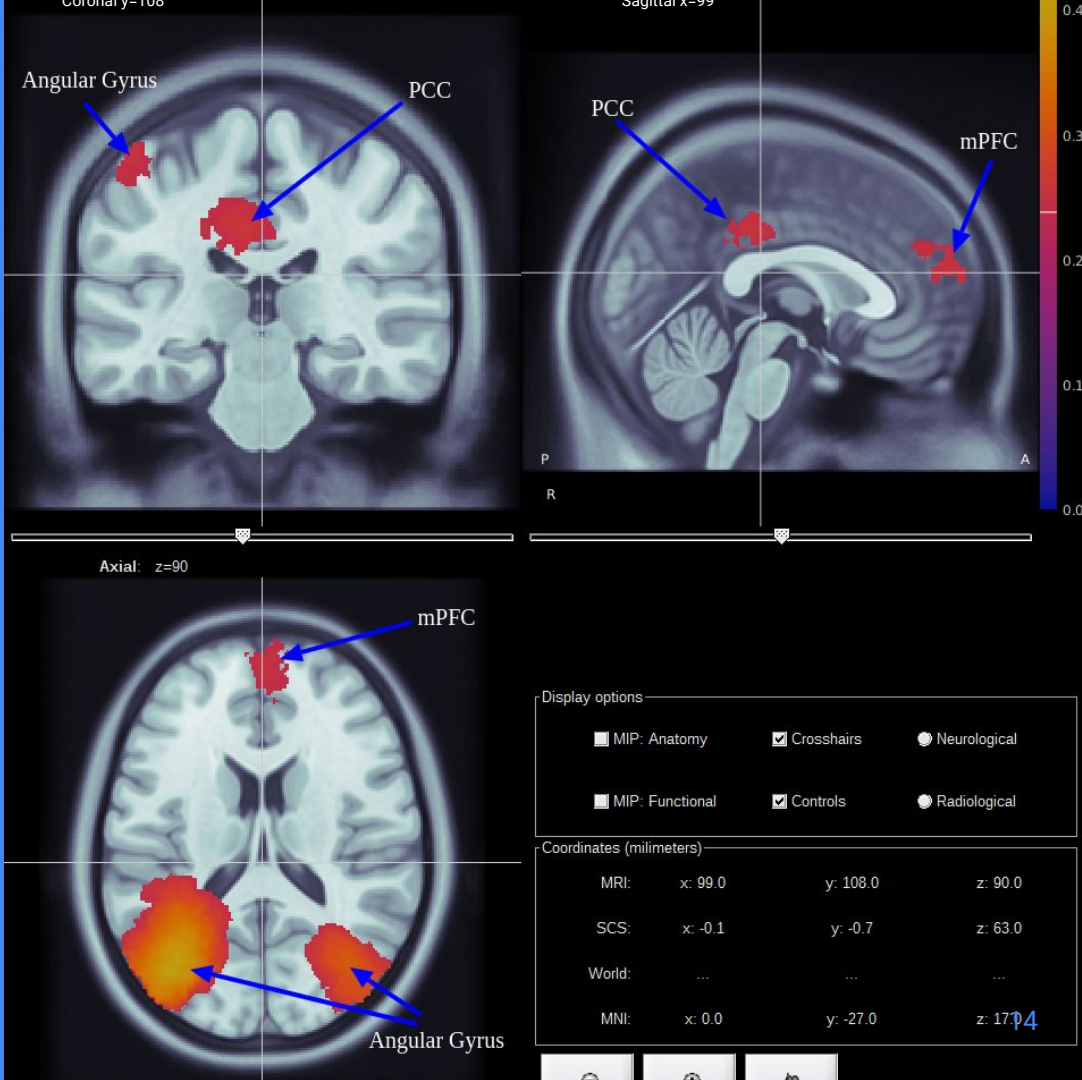
- Instrumental noise has been captured with EEG using two and more minutes of empty room measurements.
- Noise recordings were collect on same day as the subject's recordings.

## Source computation



# Result

Figure displays the sources that we found to show a statistically significant modulation on the group-level. We find the most prominent modulation of band power in the posterior cingulate cortex (PCC), which constitutes a hub of the DMN. In addition, we observe band power modulation in the medial prefrontal cortex (mPFC) and in Angular Gyrus.



# Conclusion

1

- Identified a pattern of EEG band power modulation consistent with the characterization of DMN with PET and fMRI

2

- this EEG-based identification of DMNs enables us to study the oscillatory properties of DMNs that are not accessible by PET or fMRI.

3

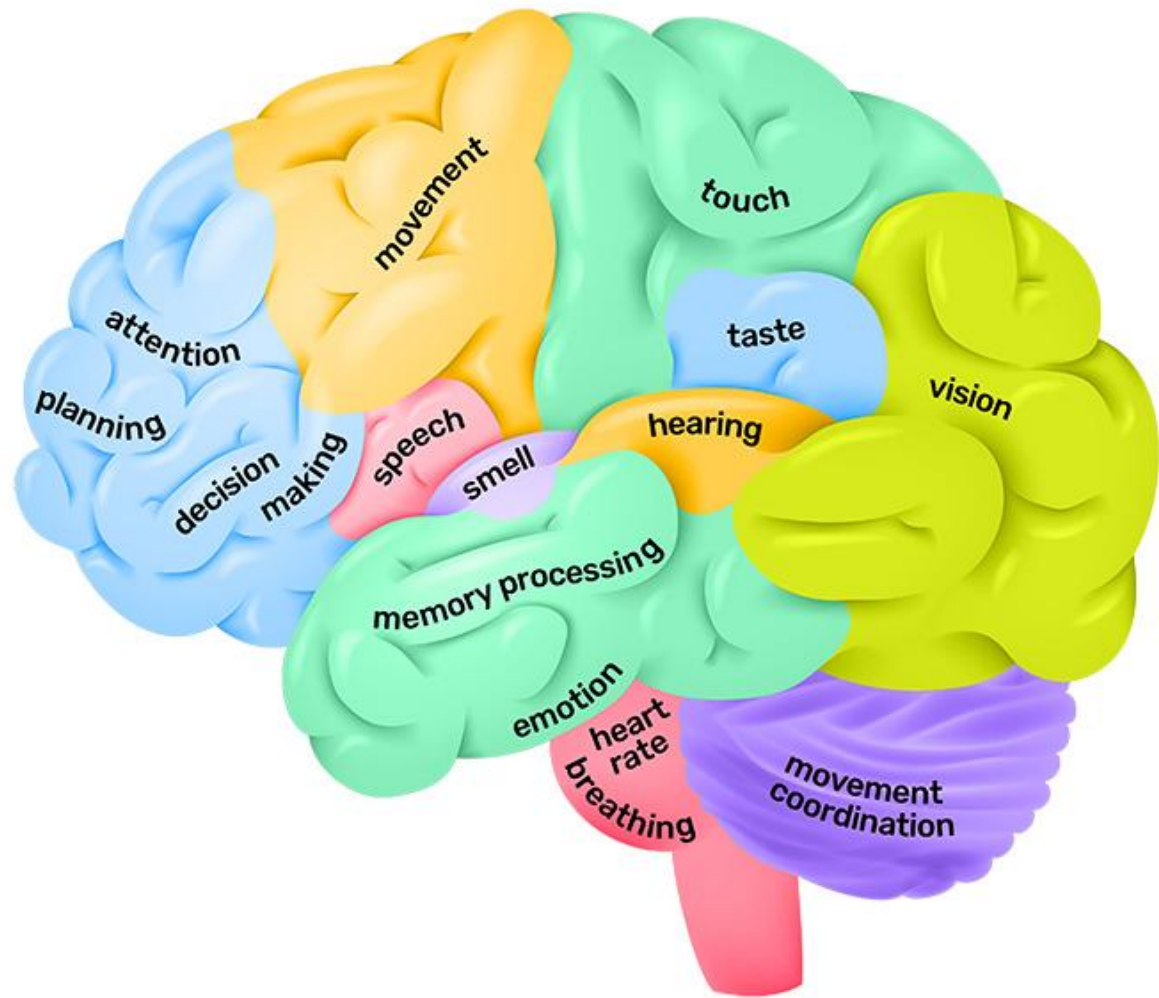
- our work makes it possible to study DMN changes in the patient



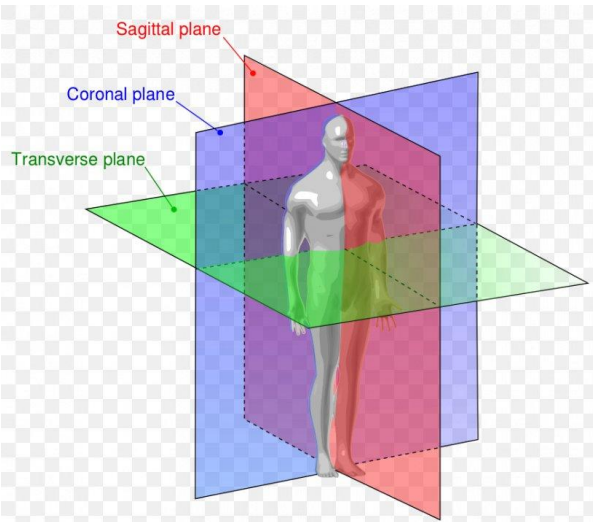
# References

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Thanks!



# Appendix



[https://favpng.com/png\\_view/free-anatomy-images-anatomy-sagittal-plane-anatomical-terms-of-location-coronal-plane-png/d4u0SKtU](https://favpng.com/png_view/free-anatomy-images-anatomy-sagittal-plane-anatomical-terms-of-location-coronal-plane-png/d4u0SKtU)