Lyon Neuroscience Research Center - CRNL

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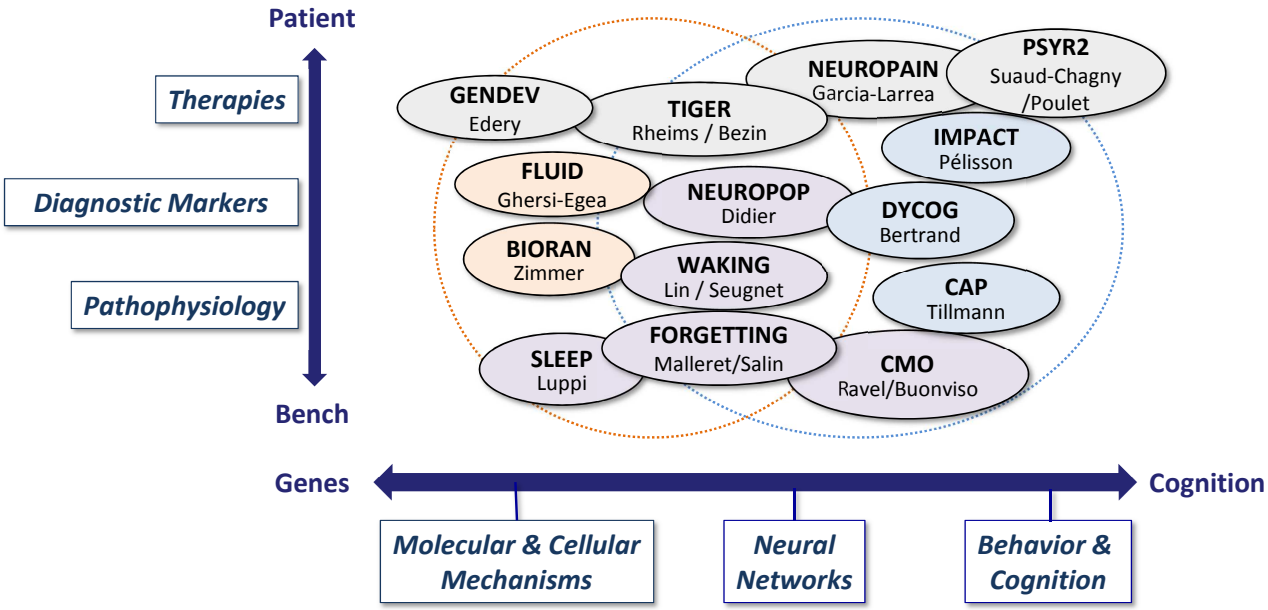
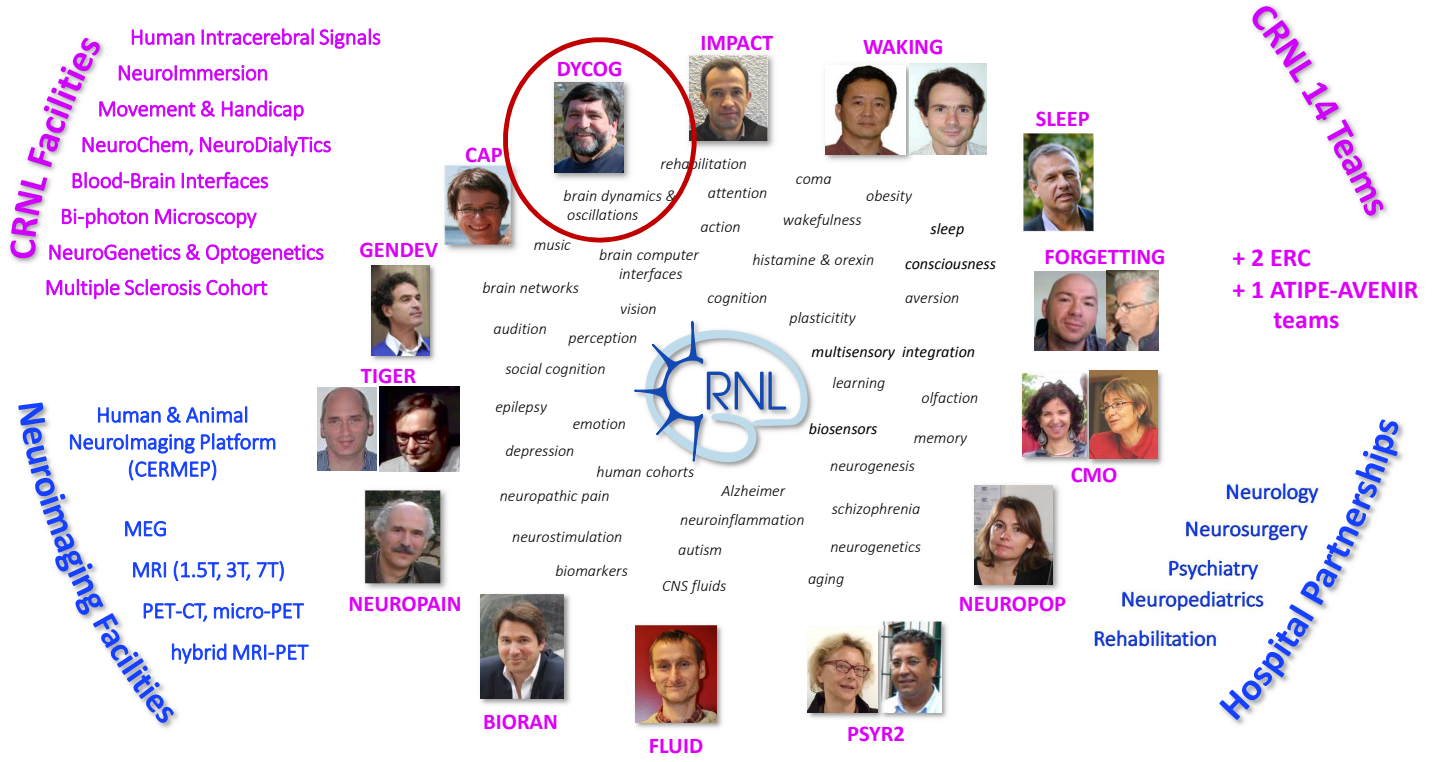
Université Jean Monnet SAINT-ETIENNE

UNIVERSITÉ DE LYON

Lyon Neuroscience Research Center - CRNL - 14 teams - 375 people

Multidisciplinary, Multi-scale, and Translational Approaches





Dir.: O. Bertrand - **375 members**: 135 Researchers, Faculties & Clinicians - 65 Engineers/Tech - 175 Docs & Post-docs

BCI research @ CRNL - Jérémie Mattout

Methodological work

Towards communication with Locked-in patients

P300-speller (visual oddball paradigm)

- **P300-speller** developed during the *OpenViBE* and *CoAdapt* projects
- Improved performances through several developments

  Margaux Perrin's PhD

  -> optimal stopping

  -> error (potential) detection

Mattout et al., Annals Phys. and Rehab. Med., 2015
Perrin et al., Adv. Hum-Comp Inter., 2012

- Recently: **endowing the P300-speller with active inference (Jelena Mladenovic's PhD, coll. F. Lotte, BCI LIFT)**

  -> enables to implement all **adaptive features** within a single algorithm instead of cumulative building blocks

  -> enables to easily incorporate new features such as optimal flashing → simulation study

- Optimal stopping: 20.1±9 flashes / 80.6% accuracy
- Optimal stop & flashing: 15.8±6 flashes / 85.2% accuracy

Mladenovic et al., NAT Conference, Berlin, 2017

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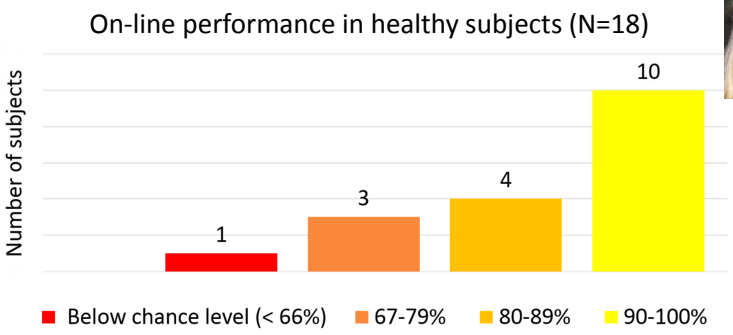
Empirical work

Extension to the auditory domain to try to communicate with patients who cannot control their eye gaze anymore

Binary BCI to answer Yes or No questions

- **Principle**:
  - rhythmic sequence of alternated «Yes» (right ear) and «No» (left ear) sounds
  - a few «Yes» and «No» stimulus have a longer duration, they act as deviant/target sounds
  - classifiers are trained to recognized attended vs. unattended standard and deviant sounds

- **Results' summary** (Perrine Seguin's medical thesis):



	Patients: offline performance	
LIS 1	-	below chance level
LIS 2	-	
LIS 3	-	
ALS 1	+ : 70 %	
ALS 2	-	
ALS 3	+ : 97 %	same perf. on-line
ALS 4	+ : 100 %	

Seguin et al., BCI Conference, Asilomar, 2016

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Empirical work

Extension to the interaction with video games for the visual training of attention (a new kind of Neurofeedback)

- ***Mind Your Brain* (FUI)** project for the training of children with ADHD (Coll. CHU Lyon, Blacksheep studio, Mensia Tech.)

- **An ongoing double-blind clinical trial (Mélodie Fouillen's PhD)**

Maby et al., Advances Hum-Comp Inter., 2012
Fouillen et al., BCI Conference, Graz, 2017

30 x 1h session, 2 sessions/week, 4 games, N=60 children
3 groups: EEG control, non-EEG control, non training

- **Rationale:**
  → a feature highly related to voluntary attentional processes (P300)
  → P300 has been shown to be impaired in ADHD children and improved when effective pharmacological treatment
  → enables to build a variety of fun games, depending on clear instructions as how to succeed in controlling the game

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Theoretical work — Better characterization of single trial responses in oddball paradigm

- A two-fold modelling approach **(Françoise Lecaignard's PhD thesis)**

Lecaignard et al., Frontiers Hum. Neurosc., 2015

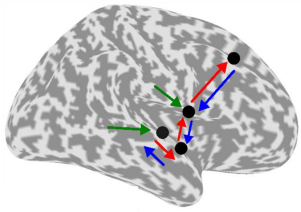
- **Psychology**: to model the sequence **learning** process

$$P(\theta|Y,M) = \frac{P(Y|\theta,M)P(\theta|M)}{P(Y|M)}$$

Bayesian Brain

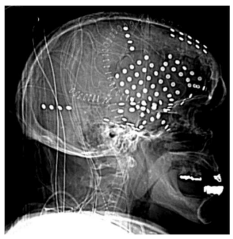
- **Physiology**: to model the **dynamic cortical network** underlying the generation of evoked responses

EEG+MEG



Dynamic Causal Modelling

ECoG



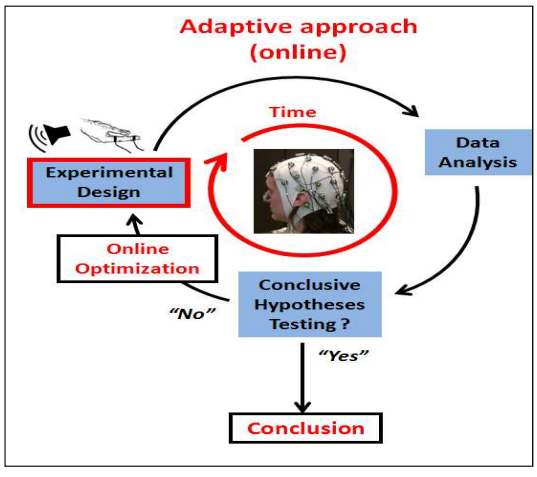
- **Recently**: exploration in epileptic patients implanted with ECoG
  (**Raphaelle Bertrand's Master**, Coll. G. Schalk and P. Brunner, Albany, USA)
- Aims:
  -> to refine our characterization of the auditory cortical hierarchy
  -> to extend our hypothesis testing to high frequency oscillations

BCI research @ CRNL - Jérémie Mattout

Theoretical work — Better characterization of single trial responses in oddball paradigm

- **Real-time data processing** can be used to optimize stimulus presentation for hypothesis testing and model comparison **(Gaëtan Sanchez's PhD thesis)**

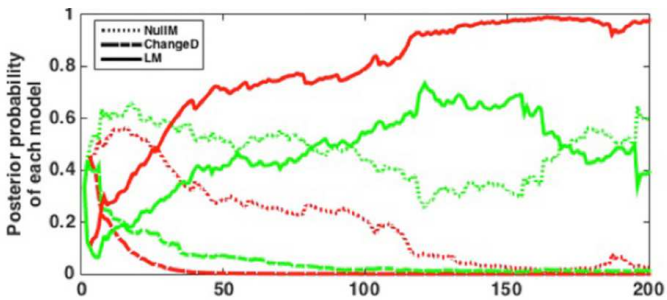
- Principle of Adaptive Design Optimization (ADO)



Sanchez et al., Brain Sciences, 2014

- Result: simulation example ADO outperforms the classical design in speed and accuracy

Sanchez et al., Frontiers Hum. Neurosc., 2016



Better separation of models with ADO

ADO
Classical design

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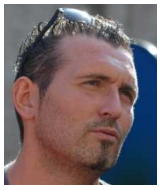

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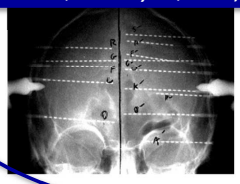
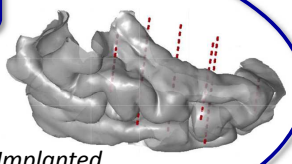
Lyon Neuroscience Research Center – Technological Platforms

Intracranial EEG
(IHU Cesame, Labex, CHU Lyon, HBP)

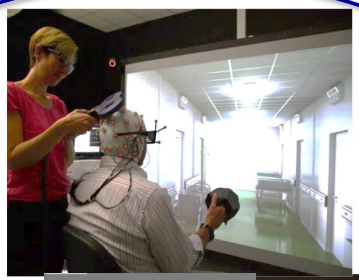




Implanted Epileptic patients

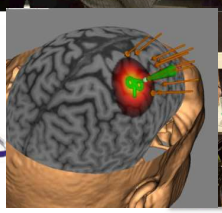
Wireless HR-EEG

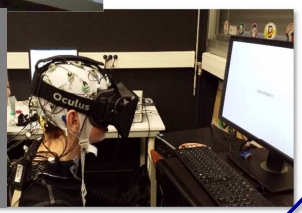
Brain Computer Interfaces



Immersive Virtual Reality

Robotized Neurostimulation





Motion & Eye tracking

NeuroImmersion
(IHU Cesame, Labex, CHU Lyon)

Mouvement & Handicap
(CHU Lyon)


NeuroCampus - 2018
6000 m²
LYON NEUROCAMPUS
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IDEE
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GENDEV
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