CER – Sorbonne Université

Comité d'éthique de la recherche

SAISINE SIMPLIFIEE

Titre du projet	COGMOOD : étude des liens entre anxiété/humeur et processus cognitifs
Date de la demande	30 avril 2020
Chercheur **correspondant** et **responsable**	**Jean DAUNIZEAU** E-mail jean.daunizeau@gmail.com Téléphone : +33629816121 Motivation Brain Behavior (MBB) Institut du Cerveau– Hôpital de la Pitié-Salpêtrière 47 Boulevard de l'Hôpital, 75013 PARIS
Personnes **associées** au projet	**Cynthia CABANAS** E-mail: cynthia.cabanas@icm-institute.org Motivation Brain Behavior (MBB) **William HOPPER** E-mail: williamjthopper@gmail.com Motivation Brain Behavior (MBB) **Juliana SPORRER** E-mail: juliana.sporrer.18@ucl.ac.uk Motivation Brain Behavior (MBB) **Karim NDIAYE** E-mail: karim.ndiaye@icm-institute.org Plateforme PRISME (ICM)
Institut principal concerné par le projet	Institut du Cerveau (ICM) – Hôpital de la Pitié-Salpêtrière
Début prévu pour la recherche	Juin 2020
Fin prévue pour la recherche	Étude longitudinale (6 mois)
Lieu(x) de déroulement de l'étude	En ligne sur l'ordinateur personnel du/de la participant(e), à son domicile.

Projet scientifique

1. Contexte et objectif

The current COVID epidemic has required extraordinary public health measures in most countries around the world. In France, lockdown has started on the 11th of March 2020, and ended on the 18th of May 2020. Most people were staying at home, in a situation of partial social isolation. In turn, this has induced psychological distress, which may have resulted in elevated anxiety and/or depressed mood. Even now, mood and anxiety might still be unstable.

From a scientific perspective, this may offer a unique opportunity to study the relationship between ongoing fluctuations of anxiety/mood states and cognitive processes. In this project proposal, we aim at exploring the co-occurring fluctuations in specific aspect of three high-level cognitive processes, namely: social influence, self-control and metacognition.

Note that beyond the primary scientific objective of our project, our proposal also serves another purpose. In brief, we hope to strengthen the epidemiologic knowledge regarding the broad psychological effects of extreme public health measures such as the current one. This may eventually help guiding socio-medical policies in future similarly adverse contexts.

2. Protocole et matériel

We will recruit 100 participants from the RISC and ICM-PRISME platforms (after having obtained their informed consent), and follow them through the lockdown period and beyond. Each participant will log in an online web testing platform (see below) according to pre-defined schedule (see below). Each testing session comprises three different cognitive tests (see below) and self-questionnaires assessing mood/anxiety and apathy, as well as a questionnaire evaluating participants' subjective assessment of their lockdown situation. Participants will receive a financial retribution that consists of a base salary (8€ per testing session) plus a performance-based bonus (maximum 8€ per session), which we detail below.

In terms of experimental scheduling, we expect this test to have good test-retest psychometric properties (in particular: session-to-session spill-over effects should be negligible). Therefore, we set the testing schedule as follows:

- Months #1 and #2: every week, with a 4-days testing window (starting each Friday).
- Months #3 and #4: every two weeks, with a 4-days testing window (starting each Friday).
- Months #5 and #6: every month, with a 4-days testing window (starting each Friday).

Note: we will need to contact each participant by email according to the testing schedule, in order to remind them of the timing of testing session.

2.1. Self-control

Self-control refers to the ability to regulate one's actions, thoughts and emotions. Stimuli that evoke emotions attract our attention more rapidly and more efficiently that "neutral" stimuli. Although this attentional bias towards emotional objects may provide some evolutionary advantage on average, it may also impair adapted cognition. For example, it may be problematic to be distracted by an emotional stimulus rather than prioritize the attentional processing of an information that is relevant

to one's current goal. In other words, emotional content is only advantageous or beneficial if it prioritizes the processing of a stimulus that is relevant for the one's current goal. However, the voluntary control of this emotional bias may be difficult, and hence demand an increased allocation of attentional resources. Our working hypothesis here is that this control results from a motivational arbitrage between the cost of cognitive effort and the ensuing benefit.

We use the so-called Rapid Serial Visual Presentation (RSVP) protocol, in which a series of fearful and neutral faces are briefly presented to the participant in a continuous flow. Participants have to detect the gender of the "target" face, which is shown right after a "distractor" face that induces an attentional blink. Let us consider the performance gap between a situation in which the target is a fearful face and the distractor is a neutral face (beneficial condition or BC), and the inverse situation (detrimental condition or DC). This gap quantifies one's inability to inhibit the emotional bias. We define "control efficacy" in terms of the reduction of this gap when reward at stake increases.

The full experimental session is a 2x3 factorial design:

- Factor 1 = reward: 2 levels (high: 2€ and low: 0.05€ per correct answer)
- Factor 2 = emotion "usefulness": 3 levels (beneficial, detrimental and control)

There are 50 trials per cell in the factorial design, which means 300 trials in total.

Participants' performance-dependant bonus depends upon the accuracy of their responses during each session (1 trial is randomly selected in each reward condition, yielding a maximal bonus of 2.05€).

2.2. Social influence

Social cognition refers to the cognitive processes involved in handling social interactions with others. It includes, but is not limited to, (i) the perception, recognition and/or understanding of others' beliefs, preferences and emotions, and (ii) the ability to influence and/or be influenced by others' beliefs, preferences and emotions. Let us consider attitudinal traits, such as prudence. From the perspective of decision theory, prudence refers to ones' subjective attitude towards risk. More precisely, someone prudent is strongly devaluating the prospect of a reward if it associated with a high risk. Here, we focus on (i) peoples' ability to recognize others' prudence from their behaviour, and (ii) the attitude alignment that ensues.

We adapt a previously published dual computational/empirical test (Devaine and Daunizeau, 2017), that alternates between *decision* and *prediction* phases. In *decision* phases, participants are asked to choose between two alternative options, which differ in terms of reward and risk (e.g., 10€ versus 10% chance of winning 100€). These alternatives are matched in terms of expected utility, and involve two different framings: namely: a loss frame and a gain frame. We measure participants' prudence and framing bias from their choices. In *prediction* phases, participants have to progressively learn the risk attitude of "dummy participants", who are presented with similar alternative options. In fact, dummy participants are artificial decision makers that reproduce realistic people behaviour. At each trial, we show participants what options are offered to the dummy participant, ask them to bet on what the dummy participant will choose, and then show them what the dummy has chosen.

We measure participants' ability to understand others' risk attitude in terms of their performance in *prediction* phases. We measure attitude alignment in terms of participants' relative change of risk attitude (between two decision phases) towards the preceding dummy (in the corresponding interleaved *prediction* phase).

The full experimental session consists of two conditions:

- The social condition comprises 5 *decision* phases, interleaved with 4 *prediction* phases. Each *prediction* phase involves a specific dummy (which is impersonated using a specific name), whose risk attitude varies according to both framing bias and risk devaluation. There are 32 trials per *decision/prediction* phase (+2 catch trials per *decision* phase), which means 298 trials in total.
- The non-social control condition comprises only 1 *prediction* phase, which is matched with the social condition in terms of learning requirements. At each trial, participants are presented with two ecological systems that differ w.r.t. two features (fertility and sensitivity to predators). They then bet on which of these two systems will yield the most offspring. At each trial, they are then told which ecosystem actually yielded the most offspring. The hidden efficacy of ecosystems is probabilistic, and matched with one of the dummy hidden value function from the social condition. We measure participants' ability to understand non-social complex systems in terms of their performance (this serves as a control for the corresponding *prediction* phase of the social condition). There 32 trials in total for the non-social condition (i.e. the experimental session consists of 330 trials).

Participants' performance-dependant bonus depends upon the accuracy of their responses in *prediction* phases during each session (1 trial is randomly selected, yielding a maximal bonus of 2€).

2.3. Metacognition

We define self-efficacy as one's belief regarding how much effort one has to invest to reach a given performance level (in any cognitive or physical task). Self-efficacy is an essential component of metacognition, and a major determinant of motivated performance, in the sense that it determines one's perceived best trade-off between reward and effort costs. Importantly, when acquiring a new skill or engaging in a new task, self-efficacy has to learned. Such self-efficacy learning may be prone to cognitive biases when acquiring a new skill. In particular, people may overweigh successes when compared to failures (optimism bias), neglect prediction errors (confirmatory biases), or report elevated levels of confidence (overconfidence bias). Here, we study the determinants of self-efficacy learning, in terms of either external feedbacks (regarding one's objective performance in a task) or internal feedbacks (regarding one's subjective confidence in the task). We also quantify the potential optimism, confirmatory and overconfidence biases that distort self-efficacy learning.

We use a simple short-term memory task that is adapted from the "Memory" game, in which people must learn the location of pairs of twin items within a 4x4 grid of cards. The pairs are presented sequentially at a rate of one pair per second. On each trial, participants are given a target number of pairs to remember to win a bonus for that trial. Participants can choose to see one presentation of all the pairs (a so-called "flip") as many times as they choose during a trial (*encoding* phase). Then, they are shown one member of each twin pair at a time and are asked to designate the

location of the corresponding twin item on the grid (*recall* phase), up to the target number of pairs for that trial. Before, they are provided with their objective performance, they then are sked to provide their confidence level in reaching the target performance level. Additionally, prior to the encoding phase, participants are asked to report the number of 'flips' of the 4x4 grid they believe they would need to achieve the target score for that trial. Finally, on certain trials, participants will not be required to complete the recall phase and instead simply report how confident they are that they would have achieved the target score.
Repeating this procedure over trials allows us to monitor the progressive update of self-efficacy and its potential associated learning biases.
The full experimental session simply consists of a repetition of 30 trials of the game.
Participants' performance-dependant bonus depends upon the accuracy of their responses during each session (1 trial is randomly selected, yielding a maximal bonus of 2€).

2.4. Questionnaires

After completion of each behavioural session, participants will be asked to answer two quick self-report questionnaires, namely: the HADS (Hospital Anxiety and Depression Scale) and the Starkstein Apathy Scale. In addition, they will be asked to fill-in a self-made questionnaire that evaluates their personal lockdown situation ("lockdown questionnaire").
Note: The questionnaires' schedule will be similar to that of the above metacognition test sessions.

3. Lieu d'expérimentation

This project proposal does not require participants to leave home and visit the host Institute (ICM, Paris). Rather, they are asked to complete cognitive tests and questionnaires on an online web platform from their personal computer (or device).

4. Modalité de recrutement des participants

Recall that this is an exploratory experiment, which means we have no prior estimate of the effect size for the power analysis. In turn, we cannot derive a formal sample size for the experiment. However, we know that the probability of participants' drop-out in longitudinal experiments is already high. We also know, previous experience with similar testing conditions, that this drop-out rate is likely to be even higher in the context of online experiments (Klindt et al, 2016). Therefore, our worst-case scenario is that 70% of participants would effectively quit before the end of the experiment, which is why we aim at enrolling 100 participants.
The participants will be recruited through RISC (Relais d'Information sur les Sciences de la Cognition: this is a specialised platform on which many people who take part in Cognitive Science experiments of various institutes in Paris are registered) as well as from the volunteer list from the ICM-PRISME facility, based on voluntary consent.
Inclusion criteria are:

- Participants must provide informed consent (see below)
- Participants must be over 18 years of age.

Exclusion criteria are:

- Participants must not have a neurological or psychiatric history.
- Participants should not be under psychotropic treatment.

- Participants must not have an ophthalmological history.

After reading an information sheet describing the purpose and data management of our online study, as well as regarding their financial retribution, participants will be asked to confirm their voluntary consent. In particular, participants will be informed that:

- They have the right to withdraw their consent at any time during the experiment, without having to justify their decision.
- Any research data that was already collected may still be used, unless the participant request that it is destroyed. However, once unidentifiable data and research results have been communicated (e.g., through academic papers), it will not be possible for them to be destroyed, withdrawn or recalled.
- To help future research and make the best use of the research data, pseudonymized test results and questionnaire scores will be shared with other academic researchers at a later stage (see "*open data*" below).
- They will receive their financial retribution if they complete the study.
- If needed, they can contact the researchers involved in the project at any point in time (an e-mail address will be provided in the information sheet).

Finally, participants will be invited to consult the help and advice of dedicated online psychological support resources (in particular: https://covidecoute.org/).

5. Conditions de traitement des informations et modalités de protection des données personnelles

After having liaised with the Data Protection Officer of Sorbonne U, we have decided to split the data processing into two independent streams: (i) *registration data* (including contact and bank details), and (ii) *experimental data* (i.e. raw test and questionnaire data). The responsible person for the former is Dr. Karim N'Diaye (PRISME platform). The responsible person for the latter is Dr. Jean Daunizeau (MBB research team). These two data processing streams have been registered at the ICM and at Sorbonne U. We note that a pre-processed subset of experimental data will be made publicly available to the wider research community. We refer to these as the "*open data*".

Experimental data

Experimental data will be collected via a psychology-dedicated software run by the ICM/PRISME and stored on a (GDPR-compliant) secured database. These data include (for each participant):

- raw trial-by-trial responses to cognitive tests
- raw item-by-item responses to stress, mood and anxiety questionnaires (see Appendices)
- raw item-by-item responses to the COVID-related questionnaire (see Apendices)
- socio-biographical data: age, gender, marital status, number and age of children, number of people who live with the participant, professional situation, education level
- a pseudonymized ID code

We note that *experimental data* do not contain any directly-identifying information: only participants' pseudonymized ID codes will be associated with their data. The pseudonymisation procedure consists in attributing each participant a unique user identifier (UUID) randomly drawn in a code table with preset alphanumeric characters (SHA256 hashing). In accordance with national legal guidelines, this database will have no connection with participants' identifying information

which will be hosted on a separate server (see below). Upon registration for the study, participant will be given their unique ID code. A backup system will copy the recorded the *experimental data* on a daily basis. These data will then be made available only to the responsible PI and his collaborators for analysis purposes. Data storage will be GDPR-compliant and will follow national regulatory standards, which ensure that the research is conducted in the interest of voluntary participants to the study. In conformity with the CNIL's reference methodology MR-004, experimental raw data will be stored up until 2 years after the results' publication.

Registration data

Registation data will be collected upon participants' registration by the ICM/PRISME platform and stored, along with participants' pseudonymized ID code (on a dedicated RedCap system). These data include (for each participant):

- Name, date and location of birth
- Contact information: email and physical address
- Item-by-item responses to the inclusion questionnaire (see Appendices)
- Banking details that are required for later financial retribution (conditional on inclusion/exclusion criteria)
- the participant's pseudonymized ID code

Importantly, *registration data* will be managed by, and only by, the ICM/PRISME platform. In particular, the ICM staff that will have access to the *registration data* excludes the researchers involved in the processing of *experimental data*. This ensures that *experimental data* cannot be related with *registration data*. Data storage will be GDPR-compliant and will follow national regulatory standards. In conformity with the CNIL's reference methodology MR-004, registration data will be stored up until 2 years after the results' publication. We note that this is the usual procedure for ICM/PRISME experiments.

Open data: The results of this study will be presented during conferences and published in peer-reviewed international scientific journals. However, no identifying data will ever be revealed, and the anonymity of the participants will always be respected and preserved. More specifically, the database repositories that we will use to share the *open data* of this project will contain exclusively (for each participant):

- raw trial-by-trial responses to the cognitive tests
- stress, anxiety and mood aggregated scores (derived from averages over questionnaires' items)
- socio-biographical data: age and gender

We note that it is impossible to identify participants based upon these data. This is because our recruitment platform (RISC, see above), relies on a participant database that has hundreds or even thousands of participants per age/gender combination.

6. Qualité de chercheurs en interaction avec les participants en cas de recherche sensible

We do not think this project proposal induces critical risks for our participants. We note that our research group has already performed online studies of this sort (see the BRAiN'US project:

https://sites.google.com/site/brainusapp/). This project was classified as 'non interventional' by the 'Comité de Protection des Personnes' (CPP Ile de France -1).
Having said this, participants will have the possibility to contact the researchers involved in the project, including the main PI (as was the case for the BRAiN'US project).

Liste, affiliation, et qualification des principaux acteurs de la recherche

Chercheur correspondant/responsable	**Jean Daunizeau** I am currently both a research group leader at *ICM* (*MBB team*, Paris, France) and an honorary fellow at *ETH* (*TNU unit*, Zurich, Switzerland). Since June 2013, I hold a tenured position (CR1 or associate professor) at ***INSERM***, France. Academic Achievements My field of expertise is **computational neuroscience**. I am regularly lecturing on related topics in highly selective graduate programs (e.g., *cogmaster, ENS*, Paris, France) and in yearly international training courses (e.g., *computational psychiatry course,* Zurich, Switzerland), some of which I organized (e.g., DCM course, Paris, France). I have **co-authored more than 70 original articles** in peer-reviewed international journals, which have been cited about 11900 times (**H-index = 52** ; see my Google Scholar profile for more information). I am (or have been) a member of the Editorial Board of a few international academic journals, including: *Neuroimage*, *PLoS Computational Biology*, *PLoS ONE*, *Frontiers in evolutionary psychology and neuroscience*, *Frontiers in brain imaging methods*, *Frontiers in perception science*. Academic Training From 2002 to 2005, I was a doctoral student both at the *Medical Imaging Research Unit* (Paris, France) and at the *Mathematics Research Centre* (Montréal, Canada). From 2006 to 2009, I performed a first post-doctoral training at the *Wellcome Trust Centre for Neuroimaging* (FIL, UCL, London, UK), under the supervision of Pr. Karl J. Friston. From 2009 to 2012, I performed a second post-doctoral training at

	the *Laboratory for Social and Neural Systems Research* (Dpt. Of Economics, UZH, Zurich, Switzerland), under the supervision of Pr. Klaas E. Stephan. Academic Degrees 2016 **BSc in psychology** *Université Paris V (Paris, France)* 2013 **Habilitation** (HDR) **in computational neuroscience** *Université Paris VI (Paris, France)* 2005 **PhD in physics** *Université de Montréal (Montréal, Canada)* 2005 **PhD in medical imaging** *Université Paris XI (Paris, France)*
Personnes supplémentaires en relation avec les participants	**Juliana Sporrer** Education **Dual MSc in Brain and Mind Sciences** Sorbonne University & Ecole Normale Superieure (FR) 2019 – 2020 **Dual MSc in Brain and Mind Sciences (Distinction)** University College London, Institute of Neurology (UK) 2018 – 2019 **BSc in Clinical Psychology (Honours)** ERASMUS: University of Kent (UK) 2017 – 2018 University Clermont Auvergne (FR) 2015 – 2018 Lab experience **Computational Unit in Motivation, Brain, Behavior Lab** *ICM, Brain and Spine Institute (FR)* 2019 – 2020. MSc project "The effect of motivation on the regulation of emotional attention" under the supervision of Dr. Jean Daunizeau **Rutledge Lab, Max Planck UCL Centre for Computational Psychiatry** **Metalab, Wellcome Centre for Human Neuroimaging**

University College London (UK)
2018 – 2019. MSc project "The effect of mood on confidence in decision-making" under the supervision of Dr. Marion Rouault, Dr. Stephen Fleming, Dr. Matilde Vaghi and Dr. Robb Rutledge

Samandouras Lab, National Hospital of Neurology and Neurosurgery
University College London Hospital (UK)
2018 – 2019. Research assistant on variations of intraoperative language testing in awake craniotomies under the supervision of Mr. George Samandouras and Dr. Matthew Kirkman

Javadi Lab, Cognitive Enhancement Lab
University of Kent (UK)
2017 – 2018 Research assistant on "The modulatory effect of oscillatory reinstatement using tACS, during sleep phases on memory consolidation for verbal stimuli" with Dr. Amir Javadi

William Hopper

Education
Dual Masters MSc Brain and Mind Sciences, September 2017 – July 2019
Second Year: **Mention Bien (75%)**
First Year: **Distinction (69%)**
Université Pierre et Marie Curie / École Normale Supérieure
University College London
BSc Biochemistry, September 2013 – July 2016
Upper Second-Class Honours (67%)
University College London

Research Experience
Dr. Jean Daunizeau; Institut du Cerveau et de la Moelle Epinière, Paris, 2019;
Second Year MSc project: A Computational Approach to Perseverance
Dr. Michael Moutoussis; University College London, 2018;
First Year MSc Project: Computational Psychiatry of Self-Esteem
Dr. Cara Vaughan; University College London, 2016;
BSc project: Pull down assays in vitro demonstrate that phosphomimetic variants of the yeast kinetochore protein Sgt1 can still bind cognate CBF3 partner proteins
Dr. Tim Green; Department of Speech, Hearing & Phonetic Science, UCL, Summer 2015;

Research Assistant: Effectiveness of computer-based training for improving speech perception in cochlear implant users
Dr. Matthew Davey; Department of Plant Sciences, University of Cambridge, Summer 2014/2015;
Summer Studentship: Growth of microalgae using nitrate-rich brine wash from the water industry

Cynthia Cabanas

Education

Dual Masters MSc Brain and Mind Sciences, septembre 2017 – juillet 2019
Université Pierre et Marie Curie / École Normale Supérieure (UPMC / ENS) + University College London (UCL).

Master en Neuropsychologie, septembre 2016
Universidad Camilo José Cela (Madrid, Espagne).
Évaluation neuropsychologique et réhabilitation

Licence en psychologie, septembre 2015
Université Complutense de Madrid (UCM) Mention: *Très Bien*
Itinéraire de neuropsychologie; Modalité bilingue (anglais-espagnol).

Programme d'échange
Vrije Universiteit - Amsterdam, Pays-Bas (9/ 2013-2/2014)
Les cours étudiés comprennent «Neuroscience cognitive» et «Gestion et organisation».

COMPÉTENCES

- Expérience avec d'expériences comportementales, TMS, EEG. Cours de sécurité IRM.
- Solides compétences en communication écrite et orale : expérience avec patients et à leur famille.
- Expérience avec programmation en MATLAB et Python, Microsoft Package et SPSS (logiciel statistique)
- Langues: maîtrise native de l'espagnol; maîtrise bilingue de l'anglais; compétence professionnelle du français

EXPÉRIENCE

Ingénieure d'études, Équipe Motivation Brain Behavior (Institut du

Cerveau et de la Moelle Épinière), Paris, France 01/2019 – **Présent**
Sous la supervision du Dr. Jean Daunizeau(MBB lab) et du Dr. Emmanuel Mandonnet (Frontlab / Hôpital Lariboisière)
Sujet de recherche: "Approche dimensionnelle et computationnelle de la cognition sociale"

- Traitement des données
- Rédaction d'articles scientifiques
- Évaluation neuropsychologique des patients avant et après chirurgie

Stagiaire en neuropsychologie, Centro de Referencia Estatal Atención al Daño Cerebral (CEADAC) Centre de référence pour le traitement des lésions cérébrales, Madrid, Espagne 04/2016 - 04/2017

- Évaluation neuropsychologique des patients + Rédaction des bilans cliniques des patients
- Organiser et donner des ateliers de réhabilitation cognitive + réhabilitation individuelle.

Population: adultes atteints de lésions cérébrales acquises (lésion cérébrale traumatique, accident vasculaire cérébral, tumeurs cérébrales, etc.)

Stagiaire en neuropsychologie, Hôpital Clinique San Carlos, Madrid, Espagne 04/2015 - 06/2016
Unité de mémoire, service gériatrique

- Évaluation neuropsychologique des patients

Intervention auprès des familles (communication d'informations et fourniture de directives de comportement).

Karim NDIAYE

En tant que responsable opérationnel de la plateforme PRISME (Plateforme de recherche sur les interactions sociales, la motivation et les émotions) à l'Institut du Cerveau (ICM), je coordonne l'ensemble des études comportementales et cognitives chez l'humain réalisées sur la plateforme, ce qui représente un volume annuel d'environ 30 études et 800 participants volontaires. Ces études emploient une grande variété de méthodologies de psychologie expérimentale, administrées au dans les salles de PRISME ou à distance via les ressources informatiques fournies par le département informatique de l'ICM.

	EXPÉRIENCE PROFESSIONNELLE Depuis mai 2018 • **Ingénieur de recherche** (IR2-CNRS), responsable opérationnel de la plateforme, PRISME à l'Institut du Cerveau (ICM). Sept 2010 – Avril 2018 • **Chercheur Postdoc** avancé à l'ICM. Supervision d'étudiants : 9 masters, 1 doctorant (2018) en co-supervision Jan 2009 - Juin 2010 • **Chercheur Postdoc junior** au Centre d'Économie de la Sorbonne & UPR640 LENA (CNRS, Paris) May 2006 - Dec 2008 • **Maitre-assistant** au Centre Interfacultaire de Sciences Affectives (CISA, Genève) &au Labnic (Neurology & Imaging of Cognition Laboratory), Université de Genève **EDUCATION** Sept 2002 - Nov 2006 • **Thèse de doctorat en Neurosciences cognitives** à l'Université Pierre-Marie-Curie Jun 2002 • **DEA (master) de Sciences Cogntives** (Université Pierre et Marie Curie, Paris) Sept 2001 • **Diplôme d'ingénieur** (ENSTA, ParisTech)

Ce protocole est soumis par DAUNIZEAU Jean (chercheur responsable du projet)