Camille JEUNET, PhD

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TRAINING - EMPLOYMENT

01-2019	**Invited researcher in the lab of Ass. Pr. Stefanie Enriquez-Geppert** Univ. Groningen, the Netherlands
Since 10-2018	**CNRS Research Scientist @ CLLE (Cognition, Speech, Language, Ergonomics)** CNRS / Univ. Toulouse Jean Jaurès, Toulouse, France
02-2018 05-2018	**Mobility in the CNBI lab [3*1 week in 2017, 4 months in 2018]** Ecole Polytechnique Fédérale de Lausanne (EPFL), Geneva, Switzerland, with Pr. José del. R. Millán
02-2017 06-2018	**EPFL/Inria post-doc fellow – "Using virtual reality and EEG-neurofeedback to improve athletic performance" [16 months]** Defitech foundation in Brain-Machine Interfaces -CNBI- (EPFL, Suisse) et project-team Hybrid (Univ. Rennes, Inria, IRISA, CNRS, France)
07 - 2016	**Mobility in the GDAC lab [1 month]** UQAM (Université du Québec à Montréal), Canada, with Pr. N'Kambou
11 - 2015 01 - 2016	**Mobility in the Interact Lab [3 months]** University of Sussex (Brighton), UK, with Pr. Subramanian
07 - 2014 09 - 2014	**Mobility in the Bristol Interaction and Graphics lab [3 months]** University of Bristol, UK, with Pr. Subramanian
10 - 2013 12 - 2016	**International IdEx PhD in Cognitive Sciences, European label -** *Supervisors:* Pr. B. N'Kaoua[1], Dr. F. Lotte[2], Dr. M. Hachet[2] & Pr. S. Subramanian[3]*; Jury :* Pr. A. Kübler[4], Pr. R. Scherer[5], Pr. D. Guehl[6] & Dr. J. Mattout[7] *[1]Univ. Bordeaux, [2]Inria, [3]University of Sussex, [4]Univ. Würzburg, Allemagne, [5]TU Graz, Autriche, [6]Univ. Bordeaux, France, [6]Inserm Lyon, France*

AWARDS - GRANTS - FUNDINGS

2020	**Best conference paper award** @ IEEE VR (Virtual Reality) 2020
2019	**PEPS grant – CNRS, InS2I** 9k€ - « VIS&REVE »: Innovating in sport training procedures using virtual reality and EEG
2018	**Best journal paper award,** second prize @ IEEE VR (Virtual Reality) 2018
2017	**PhD Award from IEEE SMC** ***(Systems, Man, Cybernetics)*****:** best PhD in Human-Machine Systems
2017	**PhD Award from IFRATH-KAELIS** for outstanding research in assistive technologies
2017	**PhD Award from the University of Bordeaux**: special prize from the international committee
2017	**Mobility grant from the Swiss National Fund** for 4 months at the EPFL, in the CNBI Lab
2016	**Post-doctoral grant**: EPFL/Inria International Lab (16 months)
2016	« **L'Oreal Unesco** Talent for Women in Science, 2016 (ranked in the top 100)
2016	« **Best teacher award** », awarded by the students in applied mathematics of the Univ. of Bordeaux

SCIENTIFIC & ADMINISTRATIVE ACTIVITIES

Teaching	*2019-2020 - Univ. Bordeaux & Univ.Toulouse Jean Jaurès (~ 60h00)* *2018-2019 - Univ. Bordeaux & Univ.Toulouse Jean Jaurès (~ 50h00)* *2015-2016 - Teaching assistant at the Univ. Bordeaux (64h00)*
PhD Committees	*2020 - Sébastien Rimbert (Inria / Univ. Nancy), Computer Sciences – Examiner* *2019 - Charles Faure (ENS Rennes / Univ. Rennes 2), Sports Sciences – Examiner* *2019 - Fanny Grosselin (ICM / Univ. Paris), Computer Sciences – Examiner* *2019 - Léa Pillette (Inria / Univ. Bordeaux), Computer Sciences – Invited*

Editorial Activities	. Guest-Editor for the research topic "Brain-Computer Interfaces for Non-Clinical (Home, Sport, Art, Entertainment, Education, Well-Being) Applications" Frontiers in Computer Sciences (Human-Media Interaction), Frontiers in Human Neuroscience (Brain-Computer Interfaces), Frontiers in Psychology (Human-Media Interaction) . Review Editor for the Brain-Computer Interaction section of Frontiers in Human Neuroscience . Review Editor for the Cognitive Neuroergonomics section of Frontiers in Neuroergonomics
Reviewing	*Expertise for the French Research Agency* – "Interaction & Robotics" committee *Scientific Journals* – IEEE Transactions in Neural Systems and Rehabilitation Engineering, Brain Science, Brain & Behavior, Journal of Multimodal User Interfaces, Laterality, PLOS ONE, Frontiers in Neuroscience, Frontiers in Human Neuroscience, Journal of Visualized Experiments, International Journal of Psychophysiology, IEEE Transactions on Human Machine Systems, Brain Research, IEEE Transaction in Biomedical Engineering, … *Conferences* – IEEE VR 2018-2020, ISMAR2019, CHI2016-2018, Graz BCI 2017,2019, SMC2016
Organisation of National & International Scientific Events	*06-2020* - Co-chair of WACAI (workshop on artificial companions and interaction), *https://wacai2020.sciencesconf.org/* (Ile d'Oleron, postponed to May 2021, ~70 people) *09-2019*- Member of the program committee of the Graz BCI Conference (GBCIC) 2019 *03-2019*- in charge of organising the CORTICO days 2019; Lille (partners: CORTICO & NExT) *05-2018*- Member of the organising committee of the NExT conference; Lyon *04-2018*- in charge of organising the CORTICO days 2018, Toulouse *04-2018*- Member of the program committee of CHI2018; Montreal *09-2017*- Member of the program committee of the Graz BCI Conference (GBCIC) 2017 *06-2017*- in charge of organising the first meeting of young researchers in BCIs and neurofeedback (JJC-ICON); Bordeaux (partners : CORTICO & NeXT) *05-2017*- Co-organisation of a BCI course @ CHI2017, USA *10-2016*- Co-organisation of a special session during the BMI Workshop on "Human factors for BMI training and operation" @ SMC2016; Budapest – Member of the program committee *05-2016*- Co-organisation of the Open-ViBE Workshop, satellite event during the International BCI Meeting; Asilomar, USA
Funding	*2019* - PEPS CNRS InS2I -- 9000€, Using EEG and virtual reality to improve athletic performance *2019* – Master internship funding by the Toulouse Brain and Mind Institute – 3000€, Acceptability of BCIs as a tool for stroke rehabilitation *2019* – Funding to invite S. Enriquez-Geppert (Univ. Groningen, Pays-Bas*)* for 3 weeks
Scientific Outreach	*2020* – Conferences for the general public: British Knowledge Transfer Network (KTN) seminar, Cafés Femmes en Sciences, Matinales tech Le Poool (Rennes) ; Radio interview: « 20mg de science » (Radio Campus Toulouse) *2019* – Conferences for the general public: Pint of Science Toulouse, Soirée débat Incognu, Festival « Je veux Savoir » *;* Conference of students: Conf'Sandwich, Seminar at the physics doctoral school of Toulouse*;* Newspapers : « Les implants cérébraux d'Elon Musk, science ou science-fiction ? » (France 24, Eco/Tech, paper of Sébastien Seibt) *2017* – Radio interview: « Que cherchent-ils ? » (RCF) *2016* – Conferences for the general public: Nuit des Chercheurs, Pint of Science Bordeaux, Media Sciences ; Radio interview: « L'oeuf ou la poule » (choc.ca)
Supervision	*PhD students in computer sciences* *since 2019* – Mr. Martin Guy – *co-supervision 30% with JM Normand & G Moreau (Centrale Nantes)* *since 2018* – Miss Camille Benaroch – *co-supervision 50% with F Lotte (Inria Bordeaux)* *Interns* *2020* – E. Tzadka (M2 biomedical engineering), E. Grevet (eq. M2 cognitive engineering), K. Forge (M1 psychology) *2018* – C. Benaroch (M2 biomedical engineering) *2017* – L. Albert (M2 computer sciences), J. Petit (eq. bachelor in computer sciences) *2016* – L. Pillette & S. Teillet (eq. M2 cognitive engineering)
Others	*since 2017* – Member of the CORTICO association that aims to promote research in the field of BCIs – board member, in charge of organising an annual series of conferences

2014-2016 – Representative of the PhD students of my doctoral school (EDSP2)

2014-2016 – Co-founder of the "Association of the PhD students of the EDSP2", board member in 2014-2015

MAIN RESEARCH PROJECTS 2016-2020

MODELLING BRAIN-COMPUTER INTERFACE (BCI) LEARNING AND PERFORMANCE TO IMPROVE USER TRAINING PROCEDURES

Non-invasive Mental Imagery-based BCIs (MI-BCIs) remain barely used outside laboratories, notably due to their limited reliability. In order to overcome this limitation, a lot of research effort has been dedicated to the improvement of EEG sensors and signal processing and machine learning algorithms. In our work, we stress the importance of understanding the psychological, cognitive and neurophysiological mechanisms that underlie MI-BCI user performance and learning in order to optimize MI-BCI efficiency. Indeed, based on this understanding, we argue that it will be possible to design innovative and relevant training procedures adapted to each patient/user that will favor MI-BCI skill acquisition. Thus, based on empirical data and on a review of the theoretical literature, I have designed a first systemic model of MI-BCI performance, including three categories of factors related to i) spatial abilities (i.e., the ability to produce, manipulate and transform mental images), ii) cognition and motivation and iii) technology acceptance (i.e., the extent to which participants feel confident and secure when interacting with the BCI). I currently co-supervise with Fabien Lotte (Inria, France) a PhD student, Camille Benaroch, who is working on the implementation of a computational model that will enable us to refine this theoretical model. Indeed, machine-learning algorithms (e.g., random forests or LASSO regressions) fed with empirical data will determine weights for each factor. In other terms, they will enable us to understand better the extent to which each factor of the model influence BCI performance and progression. Furthermore, based on this model, we started implementing innovative feedback dedicated to the improvement of BCI learning. We have shown that standard visual feedback required too many cognitive resources to be processed. Therefore, we designed an intuitive tactile feedback that appeared indeed to benefit MI-BCI performance. We have also shown that anxious and non-autonomous users experienced difficulties learning to use a BCI due to a lack of emotional support. Therefore, we designed a learning companion, called PEANUT, that provided emotional support to the BCI learners depending on their performance and progression. Our results suggest that PEANUT benefited the performance of non-autonomous users, but was detrimental for autonomous users. This stresses the importance of modeling BCI learning so that training procedures can be adapted to each user. In order to do so, we suggest to use intelligent tutoring systems.

IMPROVING THE ACCEPTABILITY TO INCREASE THE EFFICIENCY OF BCI-BASED STROKE REHABILITATION PROCEDURES

BCI-based stroke rehabilitation procedures are promising: two recent meta-analyses suggest that they enable a better motor recovery than standard procedures. Nonetheless, the expected breakthrough has not occurred yet. Their use in clinical settings is still rather limited. In our work, based on previous findings depicted earlier, we hypothesize that MI-BCI acceptability may play a major role and therefore could be a lever to improve BCI efficiency and use in the context of stroke rehabilitation. Currently, BCIs are associated with fears (e.g., "they enable reading minds") and fantasy (e.g., "they are magic, enable effortless recovery") that may both result in low engagement during therapies, and consequently in low learning. Other factors are likely to hamper BCI acceptability, e.g., the brain activity recording method that can be perceived either stigmatizing -for EEG- or risky -for invasive methods- or the long training procedures and low level of evidence that could result in low perceived usefulness. Our objective is to optimize acceptability and acceptance levels of BCIs and thereby increase the engagement of patients during their rehabilitation procedure. We think that an increased acceptability will result in better learning for the patients, and thereby in a better efficiency of BCI-based rehabilitation procedures, in turn improving the acceptability of the procedure by medical doctors and potential future patients (virtuous loop). Thus, we designed a model gathering the different factors that may influence BCI acceptability. A first experimental study (online questionnaire – 350 respondents) enabled us to highlight the most influential of these factors, among which are subjective norms (of the entourage), the perceived relevance, ease of use and playfulness of the BCI-based rehabilitation procedure. Now, in order to improve the acceptability and acceptance of BCIs for stroke rehabilitation, we will use two levers. We will first properly inform the general population about BCIs though explanatory videos. Indeed, because subjective norms seem to play a major role in acceptability, if the entourage of potential future patients is well informed about BCIs, they will more likely have a positive opinion of these technologies, which should reinforce the patient's acceptability. Second, we will personalize the therapies to each patient (e.g., by providing them with appropriate emotional support depending on their profile and needs), so that they feel more confident, more in control and less anxious during their rehabilitation.

◬ USING EEG-BASED BCIs/NEUROFEEDBACK AND VIRTUAL REALITY (VR) TO IMPROVE ATHLETIC PERFORMANCE

For long, the cognitive dimension of athletic performance has been overlooked, partly due to the difficulties encountered to objectively measure cognitive states and performance. Indeed, unlike biomechanical (e.g., stride length) or physiological (e.g., heat rate) aspects of performance, cognitive modulations are not associated with any direct sensory or proprioceptive feedback that athletes could use to improve their performance. The most specific evidence of cognitive performance is brain activity, the fluctuations of which cannot be directly perceived a priori. EEG-based BCIs and NF enable us to provide athletes with a feedback on their brain activity, for instance during motor imagery practice, which could favor learning. In addition, VR allows us to recreate ecological, realistic environments during mental practice that enable athletes to be embodied and thereby facilitates here as well their learning. While they are still imperfect, the increasing accessibility and quality of VR and EEG systems opens new opportunities for clinical, but also for non-clinical applications such as sports. Thus, our objective is to investigate how EEG and VR, could be used to enhance the cognitive and motor performance of athletes through novel training approaches. In a first study, we investigated the neurophysiological correlates of covert attention in soccer goalkeepers in the aim of designing a BCI training procedure dedicated to the improvement of their ability to process information (opponents' placement) located in their peripheral field of view. We identified power spectral patterns such as pre-trial alpha amplitude over parieto-occipital areas that could be used as robust markers for a BCI-NF training procedure.

◬ COMBINING EEG AND VR TECHNOLOGIES TO INNVESTIGATE THE NEUROPHYSIOLOGICAL CORRELATES OF EMBODIMENT

As stressed in the field of embodied cognition and mentioned earlier, embodiment has a major role in learning, and especially in motor learning. Because I would like to use BCIs combined to VR to enhance (sports) or restore (stroke) motor abilities, I am very much interested in exploring the neurophysiological correlates of embodiment. Uncovering such correlates would enable us to monitor embodiment, and especially one of its components of utmost importance, namely the sense of agency, in real-time during learning. Hence, we could adapt the virtual environment and the training procedures in order to optimize users/patients' sense of agency and thereby their motor skill acquisition. In a first study, we used VR to manipulate the participants' sense of agency during a motor task. This enabled us to highlight EEG power spectral differences in the theta band, over pre-motor and right temporo-parietal areas, between high and low sense of agency trials. We also highlighted ERP modulations, and more specifically alterations of the N200 component between both conditions. These results are in line with the literature on the neural correlates of cognitive conflict monitoring. They could therefore be of high significance beyond the field of BCIs and motor learning, e.g., for depersonalization pathologies. Based on these encouraging results, we now lead further analyses in order to estimate the extent to which variations of the sense of agency can be detected in real-time, i.e., on a single-trial basis. In the same vein, I also contribute to research that aims at investigating how system errors lower the sense of agency, and how this is reflected in the brain activity notably through error potentials.

PUBLICATIONS 2016-2020 ▼

^ PEER-REVIEWED JOURNAL PAPERS

C. Jeunet, L. Tonin, L. Albert, R. Chavarriaga, B. Bideau, F. Argelaguet, ... & R. Kulpa (2020). *"Uncovering EEG correlates of covert Attention in Soccer Goalkeepers: towards innovative Sport training procedures"* Scientific Reports, 10(1), 1-16.

C. Jeunet, D. Hauw, & J.d.R. Millán (2020). Sport Psychology: Technologies Ahead. Frontiers in Sports and Active Living, 2

L. Pillette**, C. Jeunet,** B. Mansencal, R. N'kambou, B. N'Kaoua, & F. Lotte (2020). A physical learning companion for Mental-Imagery BCI User Training. International Journal of Human-Computer Studies, 136, 102380.

F. Lotte*, **C. Jeunet***, R. Chavarriaga*, L. Bougrain*, D.E. Thompson, R. Scherer, ... & N. Dayan (2020). Turning negative into positives! Exploiting 'negative'results in Brain–Machine Interface (BMI) research. Brain-Computer Interfaces, 1-12. (* co first authors)

J.A. Micoulaud-Franchi, **C. Jeunet**, & F. Lotte (2020). Neurofeedback: a challenge for integrative clinical neurophysiological studies. Neurophysiologie Clinique/Clinical Neurophysiology.

J.M. Batail, S. Bioulac, F. Cabestaing, C. Daudet, D. Drapier, M. Fouillen, ... **C. Jeunet** et al. (2019). EEG neurofeedback research: A fertile ground for psychiatry?. L'Encéphale, 45(3), 245-255.

T. Ros, S. Enriquez-Geppert, V. Zotev, K. Young, G. Wood, S. Whitfield-Gabrieli, ... **C. Jeunet**,... & R. Thibaut (2019) "*Consensus on the reporting and experimental design of clinical and cognitive-behavioural neurofeedback studies (CRED-nf checklist)*", Brain

C. Jeunet, B. Glize, A. McGonigal, J.-M. Batail, J.-A. Micoulaud-Franchi (2018) *"Using EEG-based Brain Computer Interface and Neurofeedback Targeting Sensorimotor Rhythms to Improve Motor Skills: Theoretical Background, Applications and Prospects"*, Neurophysiologie Clinique / Clinical Neurophysiology

C. Jeunet, L. Albert, F. Argelaguet, A. Lécuyer (2018) *"Do you feel in control?: Towards novel approaches to characterise, manipulate and measure the sense of agency in virtual environments"*, IEEE Transactions in Visualization and Computer Graphics (TVCG) – Honorable mention for best paper at the IEEE VR Conference

F. Lotte, C. Jeunet (2018) "Defining and Quantifying Mental Imagery Based-BCI Users' skills: A first step", Journal of Neural Engineering, 15(4), 046030 ;

C. Jeunet, F. Lotte, J.-M. Batail, P. Philip, J.-A. Micoulaud-Franchi (2018) "Using recent BCI literature to deepen our understanding of clinical neurofeedback: A short review.", Neuroscience ;

C. Jeunet, E. Jahanpour, F. Lotte (2016) *"Why standard Brain-Computer Interface (BCI) training protocols should be changed: An experimental study",* Journal of Neural Engineering ;

C. Jeunet, B. N'Kaoua, F. Lotte (2016) *"Advances in user-training for mental-imagery based BCI control: Psychological and cognitive factors and their neural correlates"*, Progress in Brain Research.

H. Si-Mohammed, J. Petit, C. Jeunet, F. Argelaguet, F. Spindler, A. Evain, N. Roussel, G. Casiez, A. Lécuyer (2018) *"Towards BCI-based Interfaces for Augmented Reality: Feasibility, Design and Evaluation"*,IEEE Transactions in Visualization and Computer Graphics (TVCG)

C. Jeunet, E. Jahanpour, F. Lotte (2016) *"Why standard Brain-Computer Interface (BCI) training protocols should be changed: An experimental study",* Journal of Neural Engineering

C. Jeunet, B. N'Kaoua, F. Lotte (2016) *"Advances in user-training for mental-imagery based BCI control: Psychological and cognitive factors and their neural correlates"*, Progress in Brain Research

^ PEER-REVIEWED CONFERENCE PAPERSRTICLES DE CONFERENCES, WITH PROCEEDINGS & TALK

C. Benaroch, C. Jeunet, & F. Lotte. Are users' traits informative enough to predict/explain their mental-imagery based BCI performances? Graz International BCI Conference, 2019

C. Jeunet, B. N'Kaoua & F. Lotte, *"Towards a cognitive model of MI-BCI user training"*, 7th international BCI conference, 2017

F. Lotte & C. Jeunet, *"Online classification accuracy is a poor metric of mental-imagery based BCI (MI-BCI) user performance: An experimental demonstratoin and new metrics"*, 7th international Graz BCI conference, 2017

L. Pillette, C. Jeunet, B. Mansencal, R. N'Kambou, B. N'Kaoua & F. Lotte, *"PEANUT : Personalised Emotional Agent for Neurotechnology User-Training"*, 7th international Graz BCI conference, 2017

S. Teillet, F. Lotte, C. Jeunet, "Towards a spatial ability training to improve Mental-Imagery based Brain-Computer Interfaces (MI-BCI) performance: A pilot study", SMC 2016

^ PEER-REVIEWED BOOK CHAPTERS

F. Lotte, C. Jeunet, J. Mladenovic, B. N'Kaoua, L. Pillette. "A BCI challenge for the signal processing community: considering the user in the loop", IET BCI Book, 2018

C. Jeunet, S. Debener, F. Lotte, J. Mattout, R. Scherer, C. Zich. "Mind the Traps! Design guidelines for rigorous BCI experiments", BCI Handbook, 2017

C. Jeunet, F. Lotte, B. N'Kaoua. "Approches d'entraînement utilisateur pour les Interfaces Cerveau-Ordinateur" from the book "Interfaces cerveau-ordinateur : méthodes, applications et perspectives", ISTE Wiley, 2016

^ NATIONAL & INTERNATIONAL INVITED TALKS

C. Jeunet, "En quoi et comment l'IA pourrait-elle permettre d'améliorer l'entraînement et l'apprentissage des utilisateurs d'Interfaces Cerveau-Ordinateur (ICO) ?", Journée IHM & IA (Paris, 2019)

C. Jeunet, "Modélisation des processus cognitifs & neurophysiologiques sous-tendant l'apprentissage neurofeedback : Le rôle central de l'attention", Conférence de la Société Neurophysiologie Clinique de Langue Française (SNCLF) (Nancy, 2019)

C. Jeunet & L. Pillette, "Interfaces Cerveau-Ordinateur (ICO) & Neurofeedback (NF) : Apprentissage et Utilisation en Rééducation", Conférence de la Société Française de Médecine physique et de Réadaptation (SOFMER) (Bordeaux, 2019).

C. Jeunet, "Interfaces Cerveau-Ordinateur : Apprendre à s'en server, s'en servir pour apprendre", Conférence présentée dans différents laboratoires : IRIT, CerCO, ToNIC, CEMES (Toulouse, France) et ISIR (Paris, France) 2019

C. Jeunet, "Modeling the factors influencing human learning in neurofeedback: Towards designing adapted and adaptive training procedures", Department of Cognitive Psychology (Groningen, Netherlands) 2019

C. Jeunet, « Comprendre et améliorer les processus d'acquisition d'habiletés cognitives et motrices par neurofeedback : l'apport d'une approche interdisciplinaire », INCIA (Bordeaux, France) 2018

C. Jeunet, « How brain-computer interfaces could benefit the motor training of surgeons », Congrès de l'Acfas 2017 – *Association francophone pour le savoir* (Montréal, Canada) 2016

C. Jeunet, « Understanding & Improving MI-BCI User-Training: Towards a new generation of efficient, reliable and accessible BCIs », Univ. Oldenburg and Univ. Freiburg (Germany) 2016
C. Jeunet, « Understanding and Facilitating BCI User-Training », Univ. Concordia (Montréal, Canada) 2016
C. Jeunet, « How Cognitive Sciences Can Contribute to Research in Brain-Computer Interaction », National Cognitive Science Conference (San Diego, USA) 2016