Research evaluation

EVALUATION REPORT OF THE UNIT

UNICOG - Neuroimagerie cognitive

UNDER THE SUPERVISION OF THE FOLLOWING ESTABLISHMENTS AND ORGANISMS:

Université Paris Saclay

Commissariat à l'énergie atomique et aux énergies alternatives - CEA

Institut national de la santé et de la recherche médicale - Inserm

EVALUATION CAMPAIGN 2024-2025

GROUP E

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High Council for evaluation of research and highter education

In the name of the expert committee:

Frédérique Liégeois, chairwoman of the committee

For the Hcéres:

Stéphane Le Bouler, acting president

In accordance with articles R. 114-15 and R. 114-10 of the Research Code, the evaluation reports drawn up by the expert committees are signed by the chairmen of these committees and countersigned by the president of Hcéres.

To make the document easier to read, the names used in this report to designate functions, professions or responsibilities (expert, researcher, teacher-researcher, professor, lecturer, engineer, technician, director, doctoral student, etc.) are used in a generic sense and have a neutral value.

This report is the result of the unit's evaluation by the expert committee, the composition of which is specified below. The appreciations it contains are the expression of the independent and collegial deliberation of this committee. The numbers in this report are the certified exact data extracted from the deposited files by the supervising body on behalf of the unit.

MEMBERS OF THE EXPERT COMMITTEE

Chairperson:	Ms Frédérique Liégeois, University College London, United Kingdom
Experts:	Mr Christophe Bernard, Institut national de la santé et de la recherche médicale, Marseille (representative of CSS Inserm) Mr Bogdan Draganski, Centre hospitalier universitaire vaudois, Switzerland Mr Peter Hagoort, Max Planck Institute for Psycholinguistics, The Netherlands Ms Anne Kavounoudias, Aix-Marseille Université, Marseille (representative of CNU) Mr Denis Schwartz, Institut national de la santé et de la recherche médicale, Lyon (supporting personnel)

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Mr Xavier Mariette, Université Paris-Saclay

Ms Laurence Parmentier, Institut national de la santé et de la recherche médicale

Ms Annie Rivoallan, Commissariat à l'Energie Atomique

CHARACTERISATION OF THE UNIT

- Name: Cognitive Neuroimaging unit
- Acronym: UNICOG
- Label and number: Inserm u992
- Composition of the executive team: Mr Stanislas Dehaene & Christophe Pallier (deputy director)

SCIENTIFIC PANELS OF THE UNIT

SVE Sciences du vivant et environnement
SVE5 Neurosciences et troubles du système nerveux

THEMES OF THE UNIT

The Cognitive Neuroimaging (UNICOG) unit's overarching goal is to enhance our understanding of the brain mechanisms of cognitive functions in humans. Its focus is on the singularity of the human brain, and includes decision making under uncertainty (representation of numbers, probabilities, confidence), acquisition and processing of languages (including mathematics and music), learning during brain development, sense of time, and consciousness assessment. To achieve these goals, the methodological focus is on the development and application of non-invasive brain imaging using Magnetic Resonance Imaging (MRI), electroencephalography (EEG) and magnetoencephalography (MEG) coupled with intracranial recordings and behavioral studies of volunteers. The acquired multi-scale and multi-modal data is integrated using computational modeling of the underlying cognitive processes. Given the observational or correlational nature of brain activity recordings during cognitive paradigms, the unit has developed techniques that interfere with brain activity and therefore test causal relationships in non-human primates.

HISTORIC AND GEOGRAPHICAL LOCATION OF THE UNIT

Historically, the unit was created in 2002 as part of the Service Hospitalier Frédéric Joliot in Orsay. The Unicog unit is now located on the CEA Saclay campus, in the NeuroSPIN building. NeuroSPIN is a research center dedicated to innovation in brain imaging, inaugurated in January 2007, with Unicog as one of the founding research units. The centre is recognised nationally and internationally as a major infrastructure for biomedical imaging. Team 1 is also located at the Institut de Neuromodulation, Ste Anne (INM) in the centre of Paris. It has approximately 350 square meters of office space (7 offices, 2 large open spaces, 1 meeting room, 1 common room) for basic research. Team 1 also has experimental laboratory space on the clinical floor of the INM, with three dedicated rooms for participant testing (including an isolated one for EEG recordings).

RESEARCH ENVIRONMENT OF THE UNIT

UNICOG is one of the four research groups of the NeuroSPIN research center, located on the CEA Saclay campus. It is funded by five French governmental entities: Inserm, CEA, Université Paris Saclay, CNRS and Collège de France**.** The unit is at the heart of a high-level dynamic local research environment, with access to first-class (3 and 7T MRI, MEG) or even unique (11.7T MRI scanner) imaging platforms. The unit makes excellent use of these tools either through collaborative research projects (e.g. on the 7T, 11.7T for example) or through direct management of the resources themselves (MEG or baby EEG lab). The unit is very much involved in the life of NeuroSPIN through scientific and technical collaboration, but also through the management of more administrative tasks (Ethics procedures, recruitment of volunteers) and the dissemination of results (sharing of technical and methodological knowledge). On a larger scale, the unit also benefits from external technological resources not available locally thanks to national or international collaborations (e.g., intracerebral recordings with the INS in Marseille, and with four teams in the USA).

UNIT WORKFORCE: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	3
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	2
Chargés de recherche et assimilés	6
Personnels d'appui à la recherche	15
Sous-total personnels permanents en activité	**26**

Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	5
Post-doctorants	10
Doctorants	13
Sous-total personnels non permanents en activité	**28**
Total personnels	**54**

DISTRIBUTION OF THE UNIT'S PERMANENTS BY EMPLOYER: in physical persons at 31/12/2023. Non-tutorship employers are grouped under the heading "others".

Nom de l'employeur	EC	C	PAR
CEA	0	4	9
Inserm	0	2	5
Autres	3	2	1
Total personnels	**3**	**8**	**15**

GLOBAL ASSESSMENT

The overall UNICOG unit's profile is outstanding. Over the period, the unit has made major scientific contributions to the field of neurosciences in diverse areas including non-human primate cognition, consciousness, cognitive development, theories, and neuroimaging, at multiple scales. For example, they have shed light on how the human brain processes regularities (Nature Human Behaviour, 2022) and time (Proceedings of the National Academy of Science – *PNAS,* 2022), how humans and baboons process geometric shapes (PNAS, 2021), how infants develop symbolic representations (*PNAS*, 2019) and the role of thalamus in consciousness (Science Advances, 2022). They have obtained an outstanding level of competitive funding (all teams with ERC and/or ANR grants) and have published in highly regarded specialized as well as general readership journals (Nature, Science groups). The unit benefits from an outstanding research environment to achieve its scientific objectives, with cutting-edge noninvasive neuroimaging methods at NeuroSPIN, as well as excellent technical support. Crucially, all individual teams have excellent to outstanding profiles, with early career researchers contributing significantly to both outputs and funding.

DETAILED EVALUATION OF THE UNIT

A - CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The unit has implemented almost all recommendations of the previous evaluation report.
As recommended, a deputy director has been appointed. This staff member will replace the director if he is unavailable.
A formal representative body of Postdocs and PhDs has been put in place, to enable a discussion of issues of common concerns with the leadership of the unit.
As suggested, the size of the smaller teams has been expanded, although due to some unforeseen departures in teams 1 (Brain computations) and 5 (Primate cognition & consciousness), this was also confronted with some drawbacks.
The number of cross-team collaborations has increased, although this is very strongly linked to the contributions of the current unit director.
The number of external collaborations inside NeuroSPIN has increased as shown for example by the joint projects developed with teams in France and around the world performing depth recordings in epileptic patients.
The mandate of the safety officer and laboratory manager has increased, to deal with cases of confidential issues (e.g. regarding scientific integrity, bullying, sexual harassment).
The unit was however unable to address the lack of flexibility in terms of working hours and support outside a typical working week, as this is beyond their control and related to CEA security policies.

B - EVALUATION AREAS

EVALUATION AREA 1: PROFILE, RESOURCES AND ORGANISATION OF THE UNIT

Assessment on the scientific objectives of the unit

The scientific objectives of the unit are ambitious and highly topical in the field of neuroscience. They focus on clearly defined basic / fundamental research questions in human-specific cognition. The unit is uniquely positioned internationally to answer these questions. It has the resources and expertise to make ground-breaking discoveries, with on-site access to cutting-edge methods across species and different stages of human development. **This is clearly outstanding.**

Assessment on the unit's resources

Overall, **the level of resources of the unit is outstanding** both at human resource and funding levels. About 88% of the budget over the period (~20 M€) came from competitive grants (65% as PI). However, there are large differences at team level, with teams 2 and 3 receiving more than 70% of the competitive funding. The rest comes from the supporting institutions (2.4 M€), mainly Inserm (70%) and CEA (14%), and to a lesser extent the College de France, the University and the CNRS. Two teams (Team 2 and Team 3) have PIs employed by the CNRS and form an EMR ("Equipe mixte de recherche" or mixed research team). A total of 54 people are currently working in the unit, of which about 50% are permanent. Inserm (37%) and the CEA (32%) are the main contributors of permanent staff, followed by the CNRS to a much lesser extent. The University of Paris Saclay finances a research engineer (IR) but does not contribute to the salary of any PI. Support staff level (ITA) is at 50% for permanent position and 37% overall. The ratio between PI and technical staff is 73% which is excellent compared to other units. PhDs and postdoctoral researchers ("postdocs") represent 40% of the staff.

Assessment on the functioning of the unit

The functioning of the Unit is excellent to outstanding and in compliance with the current regulation with regular administrative laboratory councils (4 by year) involving representatives of students and post-docs. At the scientific level, weekly seminar are held together with others scientific events occurring at the NeuroSPIN level. At the unit level, dedicated members (2 permanent staff members) and procedures (regular meetings) ensure a non-discriminatory and a safe workplace in accordance with CEA regulations.

1/ The unit has set itself relevant scientific objectives.

Strengths and possibilities linked to the context

The unit has ambitious scientific objectives with great potential for translational impacts in the medical (e.g. work on consciousness), education (e.g. work on number and language processing, literacy), and fundamental theoretical fields (e.g. work on time processing). Given its local, national and international collaborations (Shanghai, Harward, MIT, Houston, Amsterdam, etc), it can address these questions at many brain scales as well as across species. The co-localization of baby EEG systems, several MRI machines, MEG, eye tracking, several cognitive tools (such as virtual reality) and animal facilities provide an exceptional setting that is internationally competitive.

Weaknesses and risks linked to the context

The committee has not been able to identify significant weaknesses in this topic.

2/ The unit has resources that are suited to its activity profile and research environment and mobilises them.

Strengths and possibilities linked to the context

At the unit level, the amount of funding is outstanding, with team funding ranging from excellent to outstanding. It is noteworthy that all the PIs were successful in obtaining highly competitive national and international grants (10 ANR, including 8 as PI, 5 ERC). This level of funding together with the very unique possibilities offered by NeuroSPIN in term of imaging technologies (from very new MEG to the unique 11.7T magnet MRI) and the data analysis methods developed locally make the research environment perfectly in line with the ambitious research objectives of the unit. Human resources are in-line with the funding with 50% of the staff members holding permanent positions and an excellent level of support staff (34%).

Weaknesses and risks linked to the context

At the team level, there is a large imbalance in funding between the teams (team 2 & 3 vs. team 1, 4, 5). However, it should be noted that the funding of teams 1, 4 and 5 is anyway already at an excellent level. The only major risk is that the internal coherence of the unit could be weakened. The limited contribution of the University of Paris-Saclay to the unit in terms of staff, as well as the limit it imposes on the number of PhD students per PI, may limit the growth of some teams. Without this limit, UNICOG would be able to provide excellent training to a larger number of PhD students.

3/ The unit's practices comply with the rules and directives laid down by its supervisory bodies in terms of human resources management, safety, environment, ethical protocols and protection of data and scientific heritage.

Strengths and possibilities linked to the context

The organization of the unit follows the rules and directives of the governing bodies. The unit holds laboratory councils and meetings at regular intervals, with representation from PhDs and post-doc and participation of all ITAs members who hold permanent positions. Two staff members (with permanent positions) are in charge of ensuring the unit is a safe and non-discriminatory place to work. It is worth mentioning the existence of a clear process inside team 4 which allowed to prevent / to resolve difficult situations arising in the everyday life in the laboratory. The ethical aspects are also well handled with dedicated persons within national and CEA rules. Similarly, data collection and regular archiving is performed with dedicated resources (HR and IT) from the hosting institution, CEA.

Weaknesses and risks linked to the context

No major weaknesses were identified relative to this topic by the committee. However, the fact that no administrative staff member is employed by CEA can slow down some processes, such as human resource contract/annual leave or security clearance.

EVALUATION AREA 2: ATTRACTIVENESS

Assessment on the attractiveness of the unit

The unit's attractiveness is outstanding, given its national and international leadership in neuroscience, its unique technological infrastructure for non-invasive brain imaging, its welcoming policy for new recruits, its international workforce, and its open attitude to science.

1/ The unit has an attractive scientific reputation and is part of the European research area.

2/ The unit is attractive because for the quality of its staff support policy.

3/ The unit is attractive through its success in competitive calls for projects.

4/ The unit is attractive for the quality of its major equipment and technical skills.

Strengths and possibilities linked to the context for the four references above

The unit has an excellent national and international scientific reputation, which has led to two memberships of the National Academy of Sciences USA. Excellence is also demonstrated by several national awards (Chevalier and Officier of the Legion d'Honneur, Chevalier of the Ordre du Mérite, CNRS medal) and committee memberships (e.g. Fyssen scientific committee, Education Nationale, Swiss foundation-Vareilles). The quality of the staff hosting policy is ensured by a laboratory manager, a welcome package for new recruits and demonstrated by the hosting of foreign researchers from Chile, Italy, Spain, Brazil and South Korea. In the last period, the unit has successfully obtained competitive funding, support from industry and charitable foundations including five ERC grants (one Starting, two Advanced, one Synergy and one POC) and participation in a European FET project (eXperience), 1.65 M€ from the Bettencourt-Schueller Foundation and ANR funds (n=10, 8 as PI). Critically, the teams benefit from a unique technological infrastructure for non-invasive brain imaging, including the world-unique 11.7T Iseult scanner, and also in a unique place, 3 human MRIs, 3 animal MRIs, one MEG, as well as various eye trackers and EEG systems. Early career researchers (PhDs and postdocs) are a very diverse workforce from countries within and beyond Europe (most postdoctoral researchers: China, Iran, Brazil; PhD students: Germany Italy, Netherlands, China). Importantly, leavers and PhD graduates have obtained positions in prestigious institutions (e.g. Oxford University, University College London, UK; Boston University, UCSA, USA; Geneva, Switzerland; Center for Private Brain Research, Shanghai, China), or private companies, demonstrating the worldwide reputation of the unit.

Weaknesses and risks linked to the context for the four references above

Most prizes, committee membership and scientific organizer positions are held by only three staff members from the three same teams.

EVALUATION AREA 3: SCIENTIFIC PRODUCTION

Assessment on the scientific production of the unit

The unit has demonstrated **excellent to outstanding scientific production**, with over 200 peer-reviewed publications in six years (2-3 per year per PI on average), including 23 high-impact publications in prestigious journals such as Nature, Science and eLife. Permanent members lead these works, paired with doctoral or post-doctoral first authors. Team 2 accounts for over 40% of the unit's publications, but others also significantly contribute to leading journals, reflecting the unit's overall excellence. The unit is committed to ethical practices and open science, sharing data and tools openly and adhering to high standards of research integrity.

1/ The scientific production of the unit meets quality criteria.

2/ The unit's scientific production is proportionate to its research potential and properly shared out between its personnel.

3/ The scientific production of the unit complies with the principles of research integrity, ethics and open science. It complies with the directives applicable in this field.

Strengths and possibilities linked to the context for the three references above

1/ The scientific production of the unit meets quality criteria.
The scientific production of the unit is considered excellent to outstanding overall. Over the past six years, unit members have published more than 200 articles in peer-reviewed journals, most of which focus on fundamental cognitive sciences with potential applications, particularly in the field of education, alongside some contributions related to clinical research in psychiatric disorders and prematurity. This total corresponds to an approximate average of seventeen papers per PI over six years (2.8 per year), which the committee considered an excellent rate. The high standard of the unit scientific production is attested by its consistent publication record in highly prestigious generalist journals in leading position (first, senior or corresponding author), with a total of 23 publications in the Nature group, PNAS, Science, Science Advances, or eLife. When a permanent member of the unit was the last author of these publications, a doctoral or post-doctoral student was systematically the first author. In addition to these publications in high-profile journals, 22 publications appeared in well-recognized disciplinary journals in leading position, including Neuron, Current Biology, PLOS Computational Biology, Cell Reports, and Journal of Neuroscience. The publication rate of the fourteen PhD students who defended their theses during the review period is excellent, with eight of them achieving more than three publications in leading positions, in prestigious journals for some of them. Of the 35 doctoral students enrolled during the 2018-2023 period, fourteen successfully defended their thesis, while six abandoned their PhD mainly for personal reasons.

2/ The unit's scientific production is proportionate to its research potential and properly shared out between its personnel.
Given the small size of the unit and the number of permanent researchers (11 to 13 researchers with 2 departures during the contract-period), scientific output is excellent to outstanding. Team 2 is the most productive, with over 40% of the unit's publications. Of note, it is also the team with the largest number of members, with a total of thirteen permanent staff (3 researchers, 10 engineers) and fourteen non-permanent staff (post-docs). Team 2 and Team 3 reached exceptional levels of publications (over 150 in total). Given the number of permanent researchers in each team, the publication rate is quite similar between the teams averaging 2-3 per PI per year. However, it should be emphasized that all the teams have an exceptional level of scientific production, each contributing to publications in high-level journals in a leading position, as shown by the major original contributions they have reported in the unit's portfolio (including several original articles published in Nature Neuroscience, Science Advances, PNAS and eLife).

3/ The scientific production of the unit complies with the principles of research integrity, ethics and open science. It complies with the directives applicable in this field.
The unit has made considerable efforts to comply with the need to respect fundamental principles of research integrity, ethics, and open science. As highlighted in the self-assessment document, members of the unit certify that "*all (their) work is conducted under ethical supervision by CEA and systematically supported by appropriate CPP or CER submissions and approvals.*" The unit demonstrates a strong commitment to open science. All members make their publications accessible in preprint format on platforms such as BioRxiv or PsyArXiv, as well as on HAL, which can be easily accessed via the unit's website (https://www.unicog.org/biblio/). Moreover, the unit has shared several human fMRI and MEG datasets on the OpenNeuro platform and actively contributes to open data-sharing initiatives in the field of non-human primate neuroimaging. The unit has also made significant contributions to open-source tools, such as an open-source MEG analysis pipeline (Team 4) and a Python-based preprocessing pipeline for fMRI data acquired from macaque monkeys (Team 5). The unit has adopted "*a systematic policy of boycotting predatory journals, including Frontiers and MDPI.*" All staff, both permanent and non-permanent, are "*warned not to accept tempting offers from such journals, including invitations to special issues or conferences.*" Individual researchers, however, make the final decision. In summary, the committee commends the unit for its substantial efforts to implement and promote FAIR practices.

Weaknesses and risks linked to the context for the three references above

There are no weaknesses in the unit's scientific output in terms of quality, merely a team imbalance in quantity.

Regarding interactions between teams, only Team 2 has co-publications with three other teams in the unit, representing 19% of the total publications of Team 1, 17% for Team 3 and 7% for Team 5. The committee found only a single co-publication between Team 4 and the other teams in the unit (Scientific Data 2020).

EVALUATION AREA 4: CONTRIBUTION OF RESEARCH ACTIVITIES TO SOCIETY

Assessment on the inclusion of the unit's research in society

The unit's contribution to society is overall excellent to outstanding. The contribution to education is exceptional since the unit director heads the Scientific Council of National Education (CSEN, France) while two other unit members participate in this council. This led to the publications of tens of reports and three books. Numerous educational softwares have been developed for numeracy and literacy. Clinical translation is very good, one staff member having identified methods to diagnose alterations in consciousness and restore consciousness with neuromodulation. There are also links with industry via CIFRE grants (metaAI project), with startups, and private sector collaborations to support some projects (e.g. Orange, SNCF).

1/ The unit stands out for the quality and the amount of its interactions with the non-academic world.

2/ The unit develops products for the cultural, economic and social world.

3/ The unit shares its knowledge with the general public and takes part in debates in society.

Strengths and possibilities linked to the context for the three references above

Interactions with the non-academic world are particularly impressive in the field of educational activities. Activities include teaching in high level institutions (e.g. Ecole Normale Superieure, Cogmaster; College de France; Ecole Polytechnique), contribution to education policy and practice via the Scientific Council of National Education, and the ongoing development of educational software (e.g. Kalulu) and public datasets (brain imaging for example). Links with the private sector also exist, notably funding by MetaAI and SNCF for public initiative projects (Petit Prince to develop tools for teaching, WildTimes to study the perception of time) and collaboration with Therasonic startup (team 5) for noninvasive treatments of neurological conditions. One joint patent is being exploited by a startup ("Neurometers") founded in 2024 to measure the cerebral activity for diagnosis applications. There is excellent sharing of knowledge with the public, via conferences, general media interventions (e.g. France Inter), and books for non-academic readerships. Among books published, one can cite "Agir pour l'éducation" or "Science et école".

Weaknesses and risks linked to the context for the three references above

The main risk identified by the committee is that most of the above contributions are led by few PIs of the unit. In the Masters programs there are annual courses, but most PI devotes less than 30 hours per year to teaching.

ANALYSIS OF THE UNIT'S TRAJECTORY

The scientific objectives remain overall consistent with those of the previous contract. Specifically, the unit continues to focus on human-specific cognitive functions, such as mathematical and symbolic concepts, sense of time, and consciousness. These will be explored using state-of-the art neuroimaging methods, neuromodulation and AI tools. The unit will undergo a few changes that represent opportunities for development. (i) Team 1 will expand to the Sainte Anne Hospital site (Institute for Neuromodulation, INM) with unique access to neuromodulation, intervention and invasive recording tools; (ii) The Team 3 leader already directs the new Child Brain Institute (Robert Debre site in Paris), of which its building is due to open in 2027.
These changes are good opportunities to strengthen UNICOG links with Hospitals in order to have easier access to cohorts of patients. This is particularly important for access to babies and infants, which represents a real challenge.
In addition, new neuroimaging systems (one MEG, one world-first 11.7T MRI, mobile EEG) will allow the unit to extend their portfolio of tools within NeuroSPIN.
The unit has already obtained significant competitive funding for projects extending to 2026 and even 2029 (over 15 funded projects, including ANR and two ERC Advanced grants as PIs and INM funding for Team 1), providing solid chances to deliver their ambitious scientific objectives in the next contract.

RECOMMENDATIONS TO THE UNIT

Recommendations regarding the Evaluation Area 1: Profile, Resources and Organisation of the Unit

Concerning the functioning of UNICOG, the Committee has several recommendations to improve an already very efficient unit.
1. For increased transparency and to ensure consistency across all PIs, the unit would benefit from an improvement of their internal repository to include authorships rules, CEA administrative/security rules, and minutes of Laboratory council meetings.
In addition, the Director of the unit should ensure that authorship rules are followed by all PIs.

2. To increase efficiency of administrative processes, a dedicated CEA administrative position would be needed for NeuroSPIN as a whole. Alternatively, one or several administrators employed by Inserm and Collège de France could have an "associate status" with CEA, and be given the necessary clearances to access the Unit's data (HR, Finances) through CEA software. They could undergo the minimum mandatory training needed to access these systems. This status would allow them to input data into the system, easing the administrative load both for the unit and for CEA staff.

3. The wellbeing monitoring process initiated by team 4 during the pandemic could be used unit-wide, as it provides examples of excellent practice in the field.

4. Regarding resources, the recommendation is to carry on with excellence and to support smaller teams to redress the team imbalance in funding, although no team is critically lacking money.

5. The committee also highlights the importance of retaining a team dedicated to early development, as this is a critical angle to examine the emergence of human-specific cognitive functions and their neural bases.

6. Finally, the unit could consider funding initiatives for early career researchers (ECRs).
To foster collaborations between PhD students and postdocs, a small budget could be dedicated to regular scientific-social events. To facilitate international networking, a NeuroSPIN annual international scientific event could also be set up where ECRs could showcase their work.

Recommendations regarding the Evaluation Area 2: Attractiveness

There are no recommendations on attractiveness except to encourage more PIs to contribute to the overall outstanding profile of the unit.

Recommendations regarding Evaluation Area 3: Scientific Production

There are no recommendations regarding the scientific production except to encourage more PIs to contribute to the major scientific articles of the unit.

Recommendations regarding Evaluation Area 4: Contribution of Research Activities to Society

The committee has few recommendations regarding the interaction with the society. It encourages more teams to contribute to the overall contribution to society, for example via public engagement activities. Similarly, given the unit's outstanding expertise in cognition and neuroimaging, more regular and extensive involvement in training (e.g., advanced courses for PhD students in coordination with PhD programs of the doctoral schools) could be developed. A thematic summer school that includes post-docs and researchers from the different teams of the unit could also increase cross-team cohesion and their contributions to society.

TEAM-BY-TEAM ASSESSMENT

Team 1: The computational brain

Name of the supervisor: Mr Florent Meyniel

THEMES OF THE TEAM

The computational brain team (team 1) focuses on computational approaches to human cognitive functions, which include higher order vision (numerosity as a visual property vs. internal manipulation during calculation), probabilistic learning and decision making (representation of confidence, inference mechanisms). The team makes use of all imaging capacities present on site, including high field functional MRI and MEG, as well as deep learning methods.

CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

Following the previous recommendations, the research program has been refocused. The two main topics – (i) brain mechanisms of visual, quantity, and manipulation; and (ii) neuro-computational models of learning and decision making - are very interesting and competitive at the international level. In addition, three principal investigators (PIs) obtained their HDR diploma, allowing them to supervise more PhD students. Funding was also obtained (2 ERC Starting grants, 2 ANR as PIs and others as co-PI) ensuring their autonomy.

WORKFORCE OF THE TEAM: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	1
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	0
Chargés de recherche et assimilés	2
Personnels d'appui à la recherche	0
Sous-total personnels permanents en activité	**3**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	1
Post-doctorants	1
Doctorants	1
Sous-total personnels non permanents en activité	**3**
Total personnels	**6**

EVALUATION

Overall assessment of the team

The computational brain team's profile is overall excellent to outstanding. It dedicates its research to computational approaches to human cognitive functions. Scientific highlights during the period include studies examining how humans estimate event probabilities from a sequence, including surprise and confidence (Nature Human Behaviour, PNAS, PloS Computational Biology). The team had 3 permanent researchers, but one (CR1 Inserm) left for the US. The team has had an excellent level of publication (31 articles, including 21 in leading positions). Notably, one in Nature Neuroscience, one in Cell Reports, one in Neuroimage, three in eLife). All four PhD students supervised during the period have published as first authors (one to three publications). The projects were extremely well funded from national and international funding bodies (ANR, ERC Starting grant, CRCNS; 2.4 M€) and mostly the INM (over 8 M€) totalling of over 10 M€. Attractivity was excellent to outstanding since many post-doctoral researchers or PhD students came from abroad (USA, Germany, China), and given the arrival of one junior PI (to be recruited), 1 PUPH, and 1 PH.

Strengths and possibilities linked to the context

The team has published 31 scientific articles including a Neuroimage (2023) where the authors identified a set of cortical regions implicated in confidence-weighting of learning, but also a Nature Neuroscience (2023) article on the neural representations of uncertainty where the authors distinguish code-driven versus correlational approaches because they lead to different and complementary findings (very good visibility, 12 citations), and one eLife (2019) article where they provide evidence for a processing mechanism dedicated to visual numerosity which is separable from the ones underlying the processing of non-numerical quantities (excellent visibility, 52 citations). The team is visible and leader of 2/3 of its publications.
Other strengths include original experimental protocols, imaging capacities and computational approaches. The team is attractive, with 3 PhDs awarded and 2 ongoing, but also 3 post-doc hired in the period, with 40% non-French. The outstanding external funding level (2.4 M€ during the last contract period, including 1 ERC Starting, ANR JCJV, ANR PRC, all as PI) reflects the importance and quality of the research. Of note, one CRCN Inserm staff member left France in 2020 for a position of Ass Prof at Chapman University (USA), having 1 PhD, I postdoc, 1 ERC starting and 1 Templeton grant - 1.8 M€ as PI. If we consider this contribution to the team up to 2020, the team's profile is even more impressive.

Weaknesses and risks linked to the context

There are no weaknesses identified for the past of this team.

Analysis of the team's trajectory

The partial relocation and interaction with INM – Sainte Anne is scientifically very promising. However, as the team will be in two locations (Unicog and Ste Anne), that are far apart, there is a risk of disconnection with Unicog. Part of the team will continue to work on the neural codes of cognition and the neural substrates of adaptive learning and flexible behaviour, moving beyond correlation, now using causal interventions and adding detailed EEG recordings. The development of intelligent neuromodulation in psychiatric conditions, and the pharmacological modulation of cognition are other promising themes. This is a nice and logical development based on the previous work.
There is a part of risk taking, in particular for the inclusion of new staff members, methodologies and approaches. INM (Ste Anne) will provide 350 sqm of space, a joint budget of 6 M€, which can be added to the existing ERC, 3 ANR as PIs, among others. Overall, the team's funding is outstanding for the next period and provides them with the support needed to achieve their scientific objectives.

RECOMMENDATIONS TO THE TEAM

We recommend maintaining the links with Unicog and ensuring that working on two remote locations is not a source of stress for staff and students.

Team 2: Languages of the brain

Name of the supervisor: Mr Christophe Pallier

THEMES OF THE TEAM

The overall theme of the research program of the team "Languages of the brain" is human singularity, hypothesized to be due to the uniquely human capacity to represent mental objects as symbolic tree structures. Although these mental objects might be domain-specific (e.g., as in language and mathematics), they share a similar compositional recursive tree-like structure. This supposed human singularity is further tested by cross-species comparisons with non-human primates. The overarching theme enables the different research strands to be connected under one coherent thematic umbrella.

CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The team was suggested to increase the number of joint projects and publications with other teams. This has happened, especially thanks to the contributions of the team leader. The project SymSym for example examined symbolic labelling in infants with EEG, and in human and non-human primates with fMRI, with joint publications in eLife and PNAS. Another line of collaborative research examined reading/letter decoding in infants, children, adults, and non-human primates (over 25 publications in the last period).

WORKFORCE OF THE TEAM: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	1
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	0
Personnels d'appui à la recherche	6
Sous-total personnels permanents en activité	**8**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	1
Post-doctorants	4
Doctorants	5
Sous-total personnels non permanents en activité	**10**
Total personnels	**18**

EVALUATION

Overall assessment of the team

The team's overall profile is outstanding, including the quality of the science. Scientific production is exceptional, both in terms of quantity (> 120 papers in the 2018-2023 period, 80% research articles vs 20% clinical reports) and in terms of quality (16 papers in Science, Nature group, PNAS). Highlights include the publication of a theoretical framework (e.g. opinion piece in highly regarded Trends in Cognitive Sciences 2022, over 100 citations) as well as experimental work, such as the discovery that the sensitivity to geometric regularity is uniquely human (*PNAS* 2021), or the effect of bilingualism on visual word form area (*Science Advances* 2023). Paradigms have been developed that allow a cross-species comparison between humans and non-human primates, such as a test of the perception of geometric regularities, published in PNAS (2021) and *eLife* (2023). Half of the papers involved the team leader as first, senior or co-author, with junior staff also in leading positions. The team was responsible for 50% of the scientific output of the UNICOG unit, with a substantial number of joint papers with researchers from the other teams. Similarly, the team is attractive

nationally and internationally (14 postdocs recruited) and has outstanding funding success (over 8 M€, over half from international competitive calls including ERC and ANR, 457 k€ with industry partners). Societal impacts are impressive, especially in the educational domain via books and resources. One PI wrote two books for the general audience in French, followed by a translation in English.

Strengths and possibilities linked to the context

The research program has a very clear overarching scientific aim: to establish the neural basis of human singularity. This overarching aim is implemented in three well-defined domains: (i) mathematics and the perception of simple geometric shapes; (ii) natural human language; (iii) visual recognition and reading. The research is published in highly renown journals and hence very visible: for example, they demonstrated that humans versus baboons have a specific sensitivity to geometric shape regularity (PNAS 2021), they also brought evidence that activity in numerous cortical regions covaries with the complexity of tone sequences encoded in memory (eLife 2023), and that acquisition of multiple writing systems can tune the visual cortex differently in bilinguals, sometimes leading to the emergence of cortical patches specialized for a single language (Science Advances 2023. The team obtained over >8M euros in research funding, around 50% from prestigious international grants (as PI, two ERC advanced grants, one NSF-ANR), the rest from national, regional, charity and industry sources. The team is attractive internationally, with 14 postdocs recruited, 10 PhDs awarded. The team has also developed international collaborations (University of Texas Houston, Shangai institute of neuroscience, Harvard psychology Department). Dissemination of the results is at a high level, partly also as a consequence of the team leader's role as head of the Conseil Scientifique de l'Education Nationale (Scientific council of the French national education system). During the period, the team published four books, developed an educational resource (tablet game) and two public datasets (one multilingual fMRI dataset, le Petit Prince; one lexical database "Lexique"). Two PIs also contributed to teaching (Ecole Polytechnique, College de France, Cogmaster at Ecole Normale Superieure).

Weaknesses and risks linked to the context

The committee did not identify weaknesses or risks for this team, except the four invitations to conferences listed during the period.

Analysis of the team's trajectory

In the next period, the team will focus strongly on aspects of mathematics, based on the ERC grant MathBrain awarded to the team leader. Again, a cross-species comparison will be part of the research agenda, to investigate commonalities with other species (e.g. a number sense, spatial maps) but also the aspects that are uniquely human (e.g. symbols with recursive combinatoriality). Part of the research will be devoted to understanding how educational settings will enable the acquisition of mathematical skills and how mathematical education changes the human brain. The neural basis of language will continue with its focus on naturalistic text comprehension, but in the coming period with the help of MEG to study its temporal dynamics. The team is further strengthened by two new staff members who have joined the team, and a young researcher in the domain of high-level cognition/language will be recruited. With the recent ERC advanced grant and the new additions to the team, its future trajectory looks bright and promising, and objectives achievable.

RECOMMENDATIONS TO THE TEAM

The team is advised to maintain the high quality of its research output, contribution to society, and education portfolio. A potential risk is that the majority of the work is from the unit leader, but the hiring of new researchers should allow others to grow in independence and develop further skills.

Team 3: Neuroimaging of Development

Name of the supervisor: Ms Ghislaine Dehane-Lambertz

THEMES OF THE TEAM

The Neuroimaging of Development team (team 3) focuses on the study of the development of cognitive functions in children, with the aim of understanding the emergence of complex cognitive functions, in particular the relationship between human brain architecture and supported cognitive operations. The second topic of interest is studying how cultures take advantage of the plasticity of the child's brain to improve performance through formal home-based or school-based education. To these aims, the team is using non-invasive brain imaging methods - high-density EEG and MEG - in infants in their first six months of life and children in kindergarten and primary school age.

CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The few recommendations from the previous report were partially followed. These included the recruitment of engineering staff, which was addressed with the securing of a CEA position and an Inserm assistant position who recruit volunteers, scan infants and young children, and preprocess the acquired data.
The second main recommendation to recruit new permanent members through the annual external recruitment campaigns by the CNRS/Inserm has not yet substantiated.

WORKFORCE OF THE TEAM: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	0
Personnels d'appui à la recherche	4
Sous-total personnels permanents en activité	**5**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	1
Post-doctorants	2
Doctorants	0
Sous-total personnels non permanents en activité	**3**
Total personnels	**8**

EVALUATION

Overall assessment of the team

The team's overall profile is outstanding with excellent to outstanding scientific production (in quantity and impact), impressive external funding (~3000k€, mostly from international calls), and significant contributions to society. For example, the team revealed speech segmentation in neonates (Dev Sci, 2023) and proposed a new unifying model of the representation of auditory sequences (eLife, 2023). A large proportion of the scientific publications are in collaboration with other team members of the unit. The team leader has obtained an ERC Advanced grant for the second time in her career. The team is committed to open science, provides code and algorithms on open science platforms.

Strengths and possibilities linked to the context

The publication output is excellent to outstanding, including 50 articles, with the team leader as first, last or co-author on 46 of these publications, in peer-reviewed journals comprising Nature Human Behavior, Elife, PNAS, Current Biology, PLos Biol, one book for general practitioners and 4 book chapters. Among their findings, they revealed that the neural bases of reading in typical children and in those struggling with reading acquisition are largely similar, but partly language-specific, in French and Chinese readers (eLife 2020). They also showed that infants can process numeric information separately from other continuous characteristics (Current Biology 2023.The scientific project benefit from an outstanding level of resources (~3000k€), mainly thanks to highly competitive international calls (ERC Advanced and Proof of concept grants). The appointment of the PI as Director of the newly created IHU "Institut Robert Debré pour le cerveau de l'enfant" (Child brain institute) is generating a new dynamic for translational research and closer contact to patients. Besides highly original and innovative experimental projects, state-of-the art MEG and high-density EEG systems, the team has access to a large-scale datasets constituted by the national assessments taken by each child in first grade (two time-points) and second grade. These datasets provide a unique source of information at the population level, which carries the potential of strong societal impact. Contribution to society is varied. The team leader has published a book for general practitioners and has taken part in committees for childhood, notably Le Comité des 1000 jours set up by French President in 2020, and is a member of the French National Education Scientific Council in charge of the kindergarten work package. The attractivity of the team is evident given the origin of the 7 post-docs hired during the evaluated period (Iran, Brazil, Argentina, China, Russia, Philippines) and of the 4 PhD trained (2 from abroad).

Weaknesses and risks linked to the context

The appointment of the team leader as Director of the newly created IHU "Institut Robert Debré pour le cerveau de l'enfant" is not only ensuring a new dynamic for translational research and closer contact to patients, but it also poses a threat given the anticipated increase in administrative load and responsibilities of the team leader. In addition, it might weaken the presence of this team and topic at the UNICOG unit. Finally, the retirement of the team leader in 2029 could weaken the developmental theme within UNICOG.

Analysis of the team's trajectory

The team's trajectory is excellent, which is supported by an excellent publication track record and the securing of a recent ERC Advanced grant by the team's PI for the 2024-2029 period. The research topics are well-aligned with the unit's main themes and making an optimal use of the existing technological and methodological infrastructure. The scientific objectives are in line with previous achievements, and funding has already been secured for the next contract (IDEE, ERC) demonstrating feasibility. The recent recruitment of two new PIs (one CPJ Inserm, one College de France) should also strengthen the team.

RECOMMENDATIONS TO THE TEAM

The committee recognizes the huge amount of work and enormous investment done by the PIs to work on infants and children. In order to not lose part of these efforts, it will be important to prepare the transition to a new team's leadership, who can take over some of the responsibilities already in the upcoming phase. In addition, the team could widen their approach to include genetic foundations of neurodevelopment in the context of their research.
The team could also consider valorising their intellectual property (IP) and spreading their educational strategies more widely, via start-ups for example.

Team 4: Cognition and Brain Dynamics (CBD)

Name of the supervisor: Ms Virginie Van Wassenhove

THEMES OF THE TEAM

The Cognition and Brain Dynamics (CBD) team investigates the role of time in human cognition through the study of several fundamental questions: implicit and explicit timing, properties of temporal cognitive map, time awareness in human brain, coding of temporal predictions / statistics at multiple scales using mainly MEG, EEG and computational models. The research is done mainly on the neurotypical brain. The team also develops cutting-edge analysis methods to characterize brain activity (oscillatory coupling, aperiodic fluctuation, slow oscillatory fluctuation, functional connectivity).

CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The team has followed the previous recommendations by securing funding (including an ERC Synergy grant in 2024), integrating one PI recruited as a CEA researcher and by developing methodological collaborations with other teams in the unit with the ANR "WHEN" and the alpha burst analysis. The committee did not find joint publications with the others teams, however, yet.

WORKFORCE OF THE TEAM: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	0
Chargés de recherche et assimilés	2
Personnels d'appui à la recherche	1
Sous-total personnels permanents en activité	**3**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	1
Post-doctorants	2
Doctorants	5
Sous-total personnels non permanents en activité	**8**
Total personnels	**11**

EVALUATION

Overall assessment of the team

The team's profile is overall excellent. It has grown into a well-structured and very successful research team during the last contract period. The publication record is excellent (including excellent journals such as 1 Nature Communication, 1 PNAS, 1 Neuroimage, 2 Cerebral Cortex, 2 Journal of Neuroscience) with contributions of all the senior PIs. Scientific highlights include the development of cutting edge tools and methods, the identification of slow oscillatory fluctuations in the human brain using MEG (Scientific Reports, 2023), and work on temporal metacognition (Journal of cognitive neuroscience, 2020). Additionally, the PhD students and post-docs published more than 20 papers as first or last authors in well recognised journals in the team topics. The team has original contributions at all levels: basic neurosciences, methods (data analysis and computational models), open science through data and methods dissemination, knowledge dissemination at the academic level but also for the general public. The level of funding obtained was excellent with more than 1M€ awarded thought competitive calls associated to the recent granting of an

ERC Synergy which will cover part of the coming term. The attractivity is also excellent to outstanding, with a large and diverse group of PhD students (5 different nationalities), visiting PhD students (coming from 5 different countries) and post-Docs. Knowledge dissemination is excellent to outstanding, with a very pro-active participation to open-science with contribution to open dataset in MEG and fMRI and substantial contributions to MEG guidelines. The team day to day life and organization seems to be particularly well handled via thorough self-assessment, allowing the handling of any difficulty (such as covid-19 impacts, PhD and mentorship).

Strengths and possibilities linked to the context

This is a well-established team with excellent contribution to basic neuroscience in the field of time perception. Team 4 makes excellent use of the technical and methodological possibilities offered by the NeuroSPIN Institute. The production is excellent to outstanding with more than twenty papers as first or last authors in peer reviewed journals (Nat. Comm., PNAS, neuroimage, Cereb Cortex, J. Neurosci.). As examples of this excellence, the work around temporal metacognition and self-estimation of time is highly visible with more than 60 citations since 2020, and the study of implicit / explicit timing is quickly gaining attention in the community with more than sixteen citations in the last two years. These works show that while brain automatically detects patterns in time from sensory input to improve our reactions and predict when events will occur, brain waves in different frequency bands [alpha, beta, and delta] help direct attention, anticipate timing, aligning neural activity with expected rhythms. The team also makes high level contribution on the methodological side and demonstrates a strong involvement in open science. The PIs are highly successful in obtaining competitive funding with 2 ANRs as coordinators and several others grants as collaborators (FET, DIM and 3 ANRs). The attractiveness of the team is obvious with 50% of the students (n=8) and post-docs (n=7) coming from abroad (Europe and outside Europe, e.g. Germany, Italy, India, China), and the implication of the team in international projects (ERC Synergy grant very recently obtained for example).

Weaknesses and risks linked to the context

The only risk identified for this team is linked to a relative scientific isolation since a single publication with the others teams was identified by the committee. However, this is mitigated by more informal methodological collaborations for data analysis especially with team 1 and team 2.

Analysis of the team's trajectory

The main objective is to consolidate the strong results obtained during the previous years. Logically the proposed research plan is a direct continuation of the previous work deepening the investigations in several areas (temporal predictions for auditions, individual's experience of time and its relation to consciousness, temporal cognitive map). These research avenues will make use of methods already well mastered by the team (MEG/EEG modalities, analysis methods [oscillatory analysis, aperiodic fluctuation, functional connectivity], computational model). These methods will be extended toward deeper parts of the brain, where the use of MEG or EEG becomes much more challenging. The plans will also involve the use of animal models, which is completely new for the team. This part may be more risky and challenging since the team have limited knowledge in this field, however this could be also a good way to increase the interactions with the others teams or the others NeuroSPIN units. The PIs have already secured funding for the coming term through at least one ANR (to 2028) and one ERC Synergy grant (2025-2031).

RECOMMENDATIONS TO THE TEAM

Team 4 is now well-established with strong results which could open the way to more collaborative scientific projects with the others teams of UNICOG (Teams 2 and 3 at least), strengthening the overall dynamic of the unit.
The use of animal model is very interesting (and encouraged by the committee) but comes with new challenges for team 4 which will necessitate strong collaborations within NeuroSPIN and / or external colleagues. Obviously, the ERC Synergy recently granted answers part of these concerns.

Team 5: Primate cognition and consciousness

Name of the supervisor: Béchir Jarrayat

THEMES OF THE TEAM

The Primate cognition and consciousness team (team 5) investigates the brain signatures of conscious processing in non-human primates using fMRI and EEG neuroimaging approaches. They have used both invasive (deep brain stimulation) and non-invasive (transcranial direct current stimulation) neuromodulation techniques to restore consciousness in anesthetized macaques or modulate brain dynamics in awake states. The team also investigated the neuronal mechanisms of conscious perception in awake non-human primates using electrophysiological approaches (Utah arrays).

CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The previous HCERES recommendation was to establish a common research strategy to coordinate and organize activities within the team. The COVID pandemic has particularly impacted this team, as managing the primate model is inherently more complex and requires more resources. Additionally, the departure of researchers (electrophysiology PI and 3-Photon imaging PI) who joined the team six years ago has significantly disrupted its scientific strategy. They decided to recenter the team activity around the neuroimaging modality and to push the technology toward ultra-high field MRI. This recommendation for a common strategy is being given greater attention for the next term.

WORKFORCE OF THE TEAM: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	1
Maîtres de conférences et assimilés	0
Directeurs de recherche et assimilés	0
Chargés de recherche et assimilés	2
Personnels d'appui à la recherche	2
Sous-total personnels permanents en activité	**5**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	1
Post-doctorants	1
Doctorants	2
Sous-total personnels non permanents en activité	**4**
Total personnels	**9**

EVALUATION

Overall assessment of the team

The overall team's profile is excellent to outstanding. Its work on non-human primates is original and unique in France and Europe and asks highly relevant neuroscientific questions. The quality of publication is excellent to outstanding (56 articles, including in Science, Science advances, Neuron, PNAS) and they have secured competitive funding (3,000 k€ over the last period, including 3 ANRs and 1 Bettencourt grant Fondation). They contribute to society via teaching, in particular by the team leader who is a full professor at the medical school (UVSQ) and through regular press releases and interviews in general media.

Strengths and possibilities linked to the context

Another strength of the team lies in the shared fMRI expertise among its members, which should foster interactions and collaborative projects. The recruitment of a full-time dedicated veterinarian and a permanent engineer for technical support and animal welfare is a key factor in ensuring the long-term sustainability of NHP studies. Despite many obstacles encountered over the last few years, the team maintained an excellent to outstanding scientific output, with 56 papers (17 in leading author position)– including original papers in high profile journals such as *Science advances* (on consciousness restoration in a macaque model), as well as Science, Neuron and PNAS. For example, they have developed a non-human primate model of loss of consciousness based on finely tuned anesthesia and demonstrated MRI signatures of consciousness as opposed to general anesthesia, a signature later confirmed in patients with disorders of consciousness (Science Advances 2022). They also investigated the modulatory effect of prefrontal cortex (PFC) transcranial direct currant stimulation on brain dynamics, both in the awake state and during anesthesia-induced loss of consciousness in non-human primates and showed a notable modification in the fMRI-based dynamic organization of the brain (Biorxiv 2024). Resources over the six year-period were overall excellent to outstanding, the team having obtained significant external research funding (around 3,000 k€ over the 6 years), 3 from ANR as PI, two contracts from regional authorities and 2 from foundations including the Bettencourt Foundation (>900k€). Attractivity of the team was also excellent to outstanding during the period with two excellent international researchers joining the team to develop electrophysiological approaches in NHPs and a geneticist who moved to study consciousness in humans using non-invasive neuromodulation approaches. The team's contribution to the PRIMatE Data Exchange (PRIME-DE) collaboration network is a clear strength, underscoring the team's commitment to advancing data-sharing.

Weaknesses and risks linked to the context

There is limited effective collaborations between the PIs, with only one article co-authored. There is inequality in publication rates between permanent members: one PI has authored more than 20 articles, representing 35% of all the team's publications, another 10, including only one in a leading position, and another, in thematic conversion, has not published an article during the 6-year period. However, a recent article has just been published, attesting to the successful integration of the PI in conversion. The team is faced with risks linked to the general and difficult context of animal experimentation with NHP. This could weaken the team's profile. The team did not obtain international or European funding during the period (except and an ERC starting grant attributed to a PI just before leaving the team in 2023).

Analysis of the team's trajectory

Following the departure of two members due to outside issues, the team has strategically refocused its research efforts on its core areas of expertise: fMRI and non-invasive neuromodulation in NHP and human models. Building on their previous works, they have defined three main lines of research, each supervised by a PI. Leveraging the recent development of a novel coil device for NHP at 7T by a team member, the team aims to investigate the mesoscale organization of the brain in NHP models using ultra-high-field MRI (7T, with future plans to expand to 11.7T). Additionally, they will continue their exploration of brain signatures of consciousness through innovative techniques, including direct focused ultrasound stimulation (FUS) and FUS-induced blood-brain barrier opening (FUS-BBBo) in anesthetized NHP. Beyond its fundamental interest, this research has great potential for clinical applications in humans. Most of their projects are already secured by national grants (ANR and Inserm Impulsion programme).

RECOMMENDATIONS TO THE TEAM

This team has the potential to attract competitive funding, therefore the committee recommends applying to larger European grants. Increased collaboration between team members would also be beneficial.

CONDUCT OF THE INTERVIEWS

Dates

Start: 8 January 2025 at 8:45 a.m.

End: 9 January 2025 at 3:30 p.m.

Interview conducted: on-site

INTERVIEW SCHEDULE

Observers (only January 8th)**:** Ms Christine Assaiante, Paris (representative of CoNRS26, online), Ms Amelyne David (Elue C of the CSS4), Mr Marin Chapelle (GHU), Etienne Hirsch (Inserm), Philippe Arhets (Inserm)

January 8		
8:45-9:15	Welcome coffee (closed-door): Visiting committee with the HCERES advisor (Room 185) NeuroSPIN, CEA/Saclay, Building 145, 91191 Gif-sur-Yvette)	
9:15-9:30	Presentation of the evaluation process to the unit by the HCERES advisor (Amphitheatre)	
9:30-10:30	Presentation of the unit scientific outputs and strategy by the lab director (30' presentation + 25'discussion)	
10:30-10:45	*Coffee break with the unit*	*(Showroom)*
10:45-12h00	**Visit of the unit and facilities**	
12:30-13:30	Lunch (closed-door with the committee and HCERES advisor) (Room 185)	
13:30-16:30	Presentation of the research results by group leaders 15' presentation, 15' discussion (Amphitheatre)	
	MEYNIEL Florent	*Brain Computations*
	PALLIER Christophe / DEHAENE Stanislas	*Languages of the brain*
	DEHAENE-LAMBERTZ Ghislaine	*Neuroimaging of Development*
15:00-15:30	*Coffee break with the unit*	
	van WASSENHOVE Virginie	*Cognition and Brain Dynamics*
	JARRAYA Bechir	*Primate Cognition and consciousness*
16h30-17:15:	Poster session tour (1 poster per Team presented by PhD students or post-docs, maximum 10 mn per poster including Q/A) (Showroom)	
17:15-18:30	Debriefing (only committee members and HCERES Scientific advisor	(Room 185)
19:00	Evening dinner (only committee members and HCERES Scientific advisor)	

January 9	
8:45-9:15	Welcome coffee (closed-door): Visiting committee with the HCERES advisor
9:15- 9h:30	Discussion with the representative of GHU
From 9h30	**Meetings with the various categories of staff (closed door) (**Room 185)
9:30	Discussion with PhD students and post-docs
10:00	Discussion with scientists (without team leaders)
10:30-11:00	*Coffee break with the unit (Showroom)*
10:30	Discussion with engineers, technicians and administrative personnel (in French)

11:00	Discussion with the team leaders
11:30-12:00	Discussion with the representative of the managing bodies (closed-door) & local representatives
12:00-12:30	Debriefing (only committee members and HCERES Scientific advisor)
12:30-13:00	Discussion with the director (closed-door) (Room 185)
13:00-14:00	Lunch (closed-door with the committee and HCERES advisor) (Room 185)
14:00-15h30	Debriefing (only committee members and HCERES Scientific advisor)
15:30	End of the visit

PARTICULAR POINT TO BE MENTIONED

The committee was impressed by the high capacity of this unit and the fantastic investment made by the PIs in their research (e.g. work with babies), and was convinced of the increased opportunities offered by their novel interactions with the Sainte-Anne and Robert Debré Hospitals in Paris.

While the supervisory bodies are very supportive of the research activities, they should be aware that administrative burdens/difficulties can affect research and researchers (e.g. lack of administrative access to human resources software at CEA, information for non-CEA researchers on how to carry out the annual evaluation of CEA technical staff they manage, etc.).

GENERAL OBSERVATIONS OF THE SUPERVISORS

The institution responsible for submitting the application, which is also responsible for coordinating the response on behalf of all the research unit's supervisors, did not submit any general observations.

The Hcéres' evaluation reports are available online:
www.hceres.fr

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