Functional Neuroimaging of the Vocalization Perception Mechanisms of the Sheep Brain

Plan de gestion de données créé à l'aide de DMP OPIDoR

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Modèle du PGD : ANR - DMP template (english)

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Résumé du projet :

As a gregarious species, sheep use olfactory, visual and auditory information during intra- and inter-species social interactions, which are critical for survival. The neural substrates of sheep olfactory and visual social interaction have been studied by cellular or electrophysiological approaches. Yet, despite the known behavioural importance of vocalizations for sheep social interaction, their auditory system remains scientifically unexplored. The SheepVoicefMRI project will use in vivo structural and functional magnetic resonance imaging (MRI) to discover the auditory network of the sheep brain, its functional organisation and its social information-processing mechanisms. To this aim, the project will consist of four tasks to be completed over 36 months.

The first task will be to localize and characterize, for the first time, the primary region of the sheep brain responsible for processing auditory stimulation. The second task will be to investigate whether, similar to humans, non-human primates and dogs, the sheep brain has specialized regions that focus on processing sheep vocalizations over all other sounds. The third task will be to map the structural and functional connectivity of these specialized regions, both between them and with other parts of the sheep brain. The fourth task aims to develop a training protocol that will enable sheep to participate, without anaesthesia or restraint, in functional MRI experiments.

The fundamental knowledge delivered by this project about the auditory perceptual and cognitive capacities of sheep will also contribute to understanding their welfare needs, determined by both physical and mental factors under current definitions of animal welfare. By establishing cognitive neuroimaging techniques capable of investigating the perceptual and cognitive capacities of livestock, SheepVoicefMRI will help to release the untapped potential of cognitive neuroscience to infer and investigate the mental lives of animals. In addition, this work will inform and facilitate translational research involving large animal, gyrencephalic models of both the healthy and diseased human brain. The project's impact will be enhanced by its implementing of the principles of Open Science: all scientific output (protocols, code, stimuli, data, publications, etc.) will be made publicly and freely available.

The project's host institution is one of only a few in the world with direct access to an MRI facility

capable of imaging livestock, that is also in the immediate vicinity of an experimental farm. The principle investigator (PI) was recruited into an experienced neuroethology team within this rare environment to apply his cognitive neuroscience expertise to cultivate the emerging field of livestock neuroimaging. Together they form a unique research group capable of achieving the ambitious objectives of SheepVoicefMRI. Thus, in line with the aims of the ANR-JCJC funding program, leading the SheepVoicefMRI project will benefit the PI's career by enabling them to advance their research objectives, moving forward their aim to lead a research team and providing further legitimacy to future applications for international research funding.

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1. Data description and collection or re-use of existing data

New magnetic resonance imaging (MRI) data will be acquired using a 3T Siemens Magnetom Verio MRI scanner.
Documentation of data provenance:

- The identity tag number of the subject, the date and time of the MR acquisition as well as many standard metadata entries are stored directly in the header of the DICOM files.
- In addition, for each MR session (from the subject entering the MRI scanner until they exit it) a hand written notebook page will record the identity tag number of the animal, the date, session start and end times, start and end times of each MR acquisition type, anaesthesia levels, heart rate, SPO2 levels, any problems encountered and initial subjective impressions of data quality.

There is no existing openly available or embargoed data source that could be re-used to achieve the aims of this project.

Raw MRI data will be acquired in DICOM format. Raw data will be converted to compressed NIFTI (.nii.gz) format as it is the file format most often required by open source MRI software.

2. Documentation and data quality

All MRI data will be organised following a specific version of the Brain Imaging Data Structure (BIDS) specification. The specific version chosen will be the current version at the time of the first data acquisition. The version used will be encoded in the metadata.
The BIDS specification has arguably become the community standard for storing various types of neuroimaging data, including MRI. It defines, the required metadata that is stored alongside the .nii.gz data in, for example, .json format; the folder structure required and; the file naming convention required. We will also follow the BIDS recommendation to include README files at the most appropriate level of the folder hierarchy. These README files will, for example, contain detailed descriptions of any missing data and or data quality issues. The BIDS specification provides recommendations for both raw and derived data storage. Following this specification will facilitate data reuse by any interested party.
During MRI data acquisition a hand written lab notebook will be completed with: detailed timing information for each different acquisition; regular noting of vital signs information (heart rate and SPO2 levels); noting of the level of anaesthesia; noting of any problems encountered etc. A photograph (.png) of this hand written lab notebook will be stored with the raw data.
A .pdf file that can be output by the MRI scanner providing a detailed description of all parameters used for each acquisition will be stored at the top level of the folder hierarchy of the raw data.

During MRI data acquisition data is subjectively checked for obvious image artifacts (e.g., artifacts caused by movement during acquisition). This enables problematic data to be immediately reacquired.

3. Storage and backup during the research process

Immediately after acquisition the raw MRI DICOM data will be placed on the host institutes local server that is managed by the local informatics team. To ensure the perennity of the data it is actually stored on two independent servers each taking advantage of RAID(6) technology.
In parallel the raw and derived data will be stored on a network-attached storage (NAS) device connected to the principle investigators computer. This NAS uses RAID(1) to automatically duplicate all files onto 2 independent hard drives.

The raw data is stored in 2 different locations (server and NAS) each of which is also backed up automatically. If one location fails it can either be recovered from its back up or from the other location.
Derived data is stored on the NAS and can be recovered from its automatic backed up and/or recomputed from the reproducible workflows.

Only the server maintainer and the MRI technician who acquired the data have direct access to the original raw data stored on the server.

The principle investigator can give password protected access to the data stored on the NAS to anyone on the local network. It is planned that access will be given to the PhD student recruited to work on this project, Elodie Chaillou and Marianne Latinus who will also be involved in analysing the data.

In regards to data protection, the data is not considered to be sensitive.

4. Legal and ethical requirements, code of conduct

No personal data will be processed.

The data for this project is collected solely by agents of French public research institutes, in particular INRAE, with funding solely from the French National Research Agency. As such and in line with the French law (n°2016-1321 pour une République numérique du 7 octobre 2016) all data will be made publicly available on open access.

This project involves animal research. European (Directive 2010/63/UE) and French (Décret 2013-118 et 5 arrêtés 1er fév 2013) law requires that the experimental procedures are accepted by an ethics committee and authorised by the Ministère de L'Agriculture et de L'Alimentation.

The project will be conducted in accordance with the INRAE charter of scientific integrity and research ethics .

5. Data sharing and long-term preservation

The data will be made openly available without restriction or embargo no later than 6 months after the end date of the project (30/01/2024).

All raw .nii.gz data files organised under the BIDS specification will be openly shared and preserved long-term on zenodo.org - data on Zenodo.org is believed to be available for at least the next 20 years. Exactly which derived files will also be openly available will be decided later and updated in later versions of this document.

Zenodo.org provides access to metadata and data files via standard protocols such as HTTP and OAI-PMH.

A Digital Object Identifier (DOI) will be attributed to the dataset when it is archived on Zenodo.org.

6. Data management responsibilities and resources

The principle investigator (Scott Love) will be responsible for all aspects of data management and will update this Data Management Plan as required.

Funding for the local storage of data is provided by the host institute. Storage of data on Zenodo.org is free to the user.

The use of open file formats, the BIDS specification and Zenodo.org help to ensure that the data will be FAIR.