
Functional adaptations in the primate shoulder joint complex

A Data Management Plan created using DMPonline.be

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Project abstract:

Humans use their arms for a variety of functions such as manipulation and throwing. What sets us apart from other primates is that our forelimbs are no longer used in daily locomotor activities. This change in forelimb function is likely related to the shift from an arboreal to terrestrial environment in our evolutionary history. But how does this translate to the shoulder? Have these changes in function led to anatomical changes in the human shoulder? Or has the loss of its weight-bearing and locomotor function decreased the selective pressure, allowing a wider variation in anatomy, thereby tolerating potentially disadvantageous traits? In this project, we will use state-of-the-art modelling techniques to develop an anatomical and biomechanical framework of the human and non-human (NH) primate shoulder. This will allow us to investigate how specific anatomical traits affect forelimb function in NH primates and compare that to what is observed in modern humans. To achieve a strong integrative approach, we have formed a multidisciplinary team allowing us to apply innovative techniques from engineering and medicine, i.e. musculoskeletal and statistical shape modelling, to the field of biological anthropology. Our strong expertise in these domains and our access to a unique digital database of primates puts us in the best possible position to embark on this exciting project.

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FWO DMP (Flemish Standard DMP)

1. Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

				Only for digital data	Only for digital data	Only for digital data	Only for physical data
Dataset Name	Description	New or reused	Digital or Physical	Digital Data Type	Digital Data format	Digital data volume (MB/GB/TB)	Physical volume
		<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • Generate new data • Reuse existing data 	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • Digital • Physical 	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • Observational • Experimental • Compiled/aggregated data • Simulation data • Software • Other • NA 	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • .por, .xml, .tab, .csv, .pdf, .txt, .rtf, .dwg, .gml, ... • NA 	<i>Please choose from the following options:</i> <ul style="list-style-type: none"> • <100MB • <1GB • <100GB • <1TB • <5TB • <10TB • <50TB • >50TB • NA 	
CT scans	raw imaging files	reuse/collect	digital	imaging data	DICOM, image data	<100GB each	
Bone meshes	3D bone meshes	reuse/generate	digital	imaging data, software (3D Slicer, Dragonfly)	STL and OBJ, project files, parametric meshes	<100MB each	
Anatomy	anatomical database of musculoskeletal measurements	collect	digital	observational	tabular (.xlsx, .csv), textual data (.txt, .docx)	<100MB each	
Anatomy photos	photographs and videos of dissections	collect	digital	observational	image data (.jpeg, .crw, .png) and video data (.mp4)	<100MB each	
Surface scans	3D surface scans	collect	digital	experimental	image data, STL	<100MB each	
Kinematics	shoulder kinematics	collect	digital	experimental	motion data (.mot, .c3d)	<100MB each	
MSM	musculoskeletal models	generate/reuse	digital	experimental, software (OpenSim)	Opensim models (.osim)	<100MB each	
Statistics	statistical analyses	generate	digital	experimental	tabular (.csv, .py, .r)	<100MB each	
Code	programming	reuse/generate	digital	software (Python, Matlab)	computational script (.py, .r, .mat)	<100MB each	
Figures	figures and illustrations	generate/reuse	digital	observational	image data (.jpeg, .crw, .png)	<100MB each	
Muscles	muscle samples	collect	physical	experimental	n/a	n/a	small samples; frozen
Specimens	cadaver material	collect/reuse	physical	experimental	n/a	n/a	large samples; frozen or curated (bones)
Animations	animations of 3D models	generate	digital	aggregated data, software (Maya, Blender)	image and video data (.stl, .mp4)	<1GB each	

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

- nonhuman primate specimens: obtained from European zoos
- code: computational scripts that were developed by our lab in the context of previous projects and scripts from public domain will be used
- musculoskeletal models: musculoskeletal models from previous projects (van Beesel et al.) and from public domain will be used (simtk.org)
- image data: CT scan data that have previously been obtained by the lab and CT scan data that have been obtained via collaboration with researchers from other institutes and from repositories (e.g., Morphosource.org, KUPRI)
- 3D bone meshes: previously generated by the lab and from repositories (e.g., Morphosource.org, KUPRI)

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

- Yes, human subject data
- Yes, animal data

Human subject data > ethical approval needed

- processing of CT scans of human volunteers and patients entails some privacy issues (processing of personal data: age, sex, patient name) and ethical approval needs to be obtained for newly collected data and for re-use of data. For part of the large database of UZGent this approval has already been obtained, but for newly collected data we need to submit a new application.
- experimental work with human material obtained from the Body Donation programme of KU Leuven and UGent requires ethical approval even though written informed consent has been obtained from each donor.

Nonhuman primate specimens > ethical approval obtained

- we will only work with nonhuman primate cadavers that have been obtained opportunistically, no animals will be sacrificed for our study.
- ethical approval has already been obtained for conducting this study by the ECD (Ethische Commissie Dierproeven) of KU Leuven.

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

- Yes

Some personal data of human subjects will be processed in the context of this project:

- demographics: age, sex, and body weight of each patient, volunteer or body donor
- imaging data: raw and processed CT scan and surface scans of bone and muscle tissue of patients, volunteers or body donors

Pseudonymization will be performed to protect the privacy of the donors, patients and volunteers. No photographs or scans will be taken from the face region, focus lies on documentation and quantification of the shoulder kinematics and morphology.

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, ...)? If so, please comment per dataset or data type where appropriate.

- No

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/Data transfer agreements/ research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- Yes

Not all imaging data (CT scan data) is our own property, some have been acquired from 3rd parties via data transfer agreements and/or collaboration agreements. These data will not be made publicly accessible, but will be stored on university servers and on the cloud during and after the project with restricted access (only researchers involved in the project).

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

2. Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g., in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, Codebook.tsv etc. where this information is recorded).

Documentation of the collected data will be done using:

- readme.txt files and inline comments for code
- github version control and annotation for code and protocols
- digital photographs of physical lab notebooks and written documentation for protocols, experiments, photographs
- text files and word documents (.txt, .docx) for protocols, statistical tests and analyses
- physical labels for primate specimens
- excel files (.xlsx) for subject information (human and nonhuman primate specimens)

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

- Yes

We will make use of a metadata standard to make our data findable and citable and adhere to the FAIR principles. We will use DataCite so that we can share our data via KU Leuven RDR and/or Zenodo.

3. Data storage & back-up during the research project

Where will the data be stored?

- secured university server
- Dropbox teams (for sharing)
- OneDrive and Google Drive (for sharing)
- external hard drives (for transportation of data between sites and as backup)
- cadaver specimens will be stored at KU Leuven Campus Kulak (dedicated freezer storage, -18 degrees)

How will the data be backed up?

- secured university server (automated daily backup)
- external hard drives > backup of data on monthly basis (manually)
- cloud storage (Dropbox, OneDrive, Google Drive) > automated backup

**Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely.
If no or insufficient storage or backup capacities are available, then explain how this will be taken care of.**

- Yes

There is sufficient storage and backup available; whenever needed additional storage space on the university server can be acquired during the course of the project.

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

Archived imaging data on university server have restricted access. The PI manages who can access these drives.

Access to human imaging data (including personal data) is restricted to only a few persons who need access to these data. These data are only available on secured university or hospital servers and cannot be stored in other places or on other devices.

Physical data (primate specimens) are stored in freezers in a locked room.

For the other data (imaging data of primates) there is a low confidentiality level and there is no need to restrict access.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

yearly cost for data storage at university server = 160 EUR /TB

yearly cost for data storage using Dropbox = 576 EUR/4 team members

These costs will be covered by the research budget of the PI (Evie Vereecke)

4. Data preservation after the end of the research project

Which data will be retained for at least five years (or longer, in agreement with other retention policies that are applicable) after the end of the project? In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

All data obtained and processed during the project will be retained at least five years after completion of the project. Only primate cadavers will not be stored for a period of five years but will either be incinerated or returned to the institute of origin after completion of the experimental work.

Where will these data be archived (stored and curated for the long-term)?

The data will be stored on secured university servers with automated daily backup.

In addition, imaging data will be stored on morphosource.org and source code will be stored on github.

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

yearly cost for data storage at university server = 160 EUR /TB

costs will be covered by the research budget of PI (Evie Vereecke)

5. Data sharing and reuse

Will the data (or part of the data) be made available for reuse after/during the project? In the comment section please explain per dataset or data type which data will be made available.

- Yes, in an Open Access repository
- CT scan data (raw and reconstructed) using Morphosource.org repository
- source code (Python) and protocols using github
- musculoskeletal models via OpenSim platform

If access is restricted, please specify who will be able to access the data and under what conditions.

some of the data will be put on data repositories with restricted access to involved researchers only; this considers imaging data that were obtained via data sharing agreements and where we do not own the data.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)? Please explain in the comment section per dataset or data type where appropriate.

- Yes, Privacy aspects
- Yes, Intellectual Property Rights

We will not be able to share some of the data, more specifically:

- data obtained via data sharing agreements
- reuse of existing human imaging data

access to these data will be restricted to involved researchers only; imaging data of human volunteers and patients will be pseudonymized and will not be shared publicly; only imaging data of nonhuman primates obtained by us in the broader context of this project will be shared publicly (after embargo or publication of the data).

Where will the data be made available? If already known, please provide a repository per dataset or data type.

- raw and reconstructed CT scan data of nonhuman primates will be published on Morphosource.org
- code will be published on github, along with metadata and protocols
- musculoskeletal models on OpenSim platform (simtk.org)
- physical data (=skeletal remains of the primate specimens) will be transferred to collaborating natural history museums or institutes (e.g. Rotterdam Natuur Historisch museum, KBIN) and stored long-term for scientific and educational purposes.

When will the data be made available?

upon publication of research results

Which data usage licenses are you going to provide? If none, please explain why.

The selection of usage license will depend on the type of data shared. We aim to provide as much data as possible under the creative common license CC-BY-NC

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

- Yes

We will add doi numbers to our datasets whenever possible (e.g. Morphosource.org provides doi numbers for imaging datasets)

What are the expected costs for data sharing? How will these costs be covered?

there are no costs expected for data sharing

6. Responsibilities

Who will manage data documentation and metadata during the research project?

PhD student

Who will manage data storage and backup during the research project?

PhD student

Who will manage data preservation and sharing?

Evie Vereecke

Who will update and implement this DMP?

Evie Vereecke