

CORE

Developing a Mammalian Behaviour Ontology

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Introduction

The EuroPhenome mouse phenotyping resource (http://www.europhenome.org)¹ is the central depository for raw phenotype data generated from carrying out the standard operating procedures (SOPs) defined for the EUMODIC high-throughput mouse phenotyping project. An ontology annotation framework is implemented within EuroPhenome which makes use of the PATO Entity and Quality (EQ) model and the species-specific Mammalian Phenotype (MP) ontology to apply 4-levels of annotation: SOP annotation; parameter annotation; qualitative data annotation; and the automatic annotation of mutant lines². This annotation framework standardises the input, storage and analysis of data across all SOPs.



An OBO Foundry-compliant ontology which defines the mammalian behaviour phenotype domain does not currently exist. The species-neutral Animal Behaviour Ontology (ABO)³ distinguishes between the ground facts about what an animal does (e.g. running, biting, vocalizing) and the functions attributed by human domain experts to the direct behaviour observations (e.g. prey capture, assertion of dominance, guarding of territory). In its current form the granularity of terms within ABO are too coarse for the description of mouse behaviours. Therefore a dedicated behaviour ontology is required to define mammalian behaviours at a useful resolution.

	compare with back	ground data	
direct phenotype mutant strain	EQ + increased / decrease frequency and MP	ed increased / decreased E <u>Q</u> statement and MP	
inferred phenotype	MP	MP	

Levels of ontology annotation of mouse phenotype data within EuroPhenome. MP = Mammalian Phenotype ontology. EQ = Entity + Quality.

Design rationale

The Mammalian Behaviour Ontology (MBO) being developed to precisely define IS mammalian behaviours, while maintaining the behavioural activity and behavioural function distinction defined by ABO. This distinction forms the two top-level classes of the ontology. The MBO also draws a fundamental distinction between activities and functions in behavioural from other individuals isolation and behaviours between individuals, which are broadly analogous to the Gene Ontology biological "adult concepts process behaviour" and "behavioral interaction between organisms". Subsequent child classes are currently in the process of being manually added. Here we present a upper-level snapshot of the current structure of the MBO.

Classes 🗁 — mammalian behaviour 🖻 🕂 🕦 behavioural activity -E+① behavioural activity between individuals. 🖃 🕂 🕕 contact activity ← 🕕 copulation 🕂 🕕 grooming 🕂 🕕 nuzzling 🕂 🕕 🕦 scratching -🖃 🕂 🕕 sexual activity └┽ – 🚺 copulation ⊡ ← ① behavioural activity of an individual ⊟←① body part movement 🗄 🕂 🕕 head movement 🗄 🕂 🚺 mouth movement ⊡←① consciousness ← 🕕 asleep 🕂 🕕 awake 🛛 🖻 🕂 🚺 emission – 🗄 🕂 🕦 excretion 🗄 🕂 🚯 external secretion 🗄 🕂 🕕 production of sound

Term population and use

As a minimum criteria set for the MBO term population, the MBO will endeavor to contain all phenotypes currently defined within the "behavior/neurological phenotype" branch of MP; the behavioral phenotypes observed during the execution of the EUMODIC behavioural SOPs; the behaviours relevant to mammals contained within ABO and within the "behavior" branch of GO; and the phenotypes defined in the Glossary of Rat Behaviours (http://www.ratbehavior.org/Glossary.htm).

The MBO is being developed in line with OBO Foundry guidelines and will shortly be made publicly available for OBO community scrutiny.

E+① interaction with environment 🗕 🕕 🚺 bathing 🗕 🕦 drinking -🗕 🕦 eating ⊡**←**① locomotion 🗕 🚺 burrowing 🗕 🚺 jumping 🗕 🕕 🕕 🕂 🕂 🕂 🕂 🕕 🕦 walking i 🖃 🕂 🚯 self-contact activity ← 🕕 self-grooming I ← ____ self-scratching 🖻 🕂 🕦 whole body movement 🗕 🕕 🕦 shaking ← 🕦 swaying 🕂 🚺 tilting 🕯 🖃 🕂 🕦 behavioural function -E+① behavioural function between individuals 🖃 🕂 🕕 parental behaviour 🕀 🕂 🚯 brooding behaviour 🗄 🕂 🕦 nursing behaviour ∃ ← ① protection of offspring behaviour 🗄 🕂 🕦 suckling behaviour 🗄 🕂 🕕 🕦 weaning behaviour 🖃 🕂 🕦 reproductive behaviour 🕀 🗲 🚯 mating behaviour 🖃 🕂 🚺 social behaviour -∃ ← ① aggressive behaviour 🗄 🕂 🕦 bonding behaviour 🗄 🕂 🚯 playing behaviour E+① behavioural function of an individual 🖃 🕂 🕕 emotional behaviour 🗄 🕂 🕦 fear related behaviour 🗄 🕂 🕕 learning and/or memory behaviour 🗄 🕂 🕦 learning behaviour 🖃 🕂 🕕 maintenance behaviour 🗄 🕂 🕕 🚺 thermoregulation behaviour + 🕕 reflex behaviour 🖻 🕂 🕕 rhythmic behaviour 🖣 🚯 sleeping behaviour

In the short-term the MBO will be an ontology of mouse and rat behaviours. It will be implemented within EuroPhenome in the composition of EQ annotations. Concepts from the MBO will assist the construction of the behavioural branch of the emerging vertebrate Trait Ontology. We anticipate the further development of the MBO to span the behaviours of other mammals, chiefly human, thus facilitating model disease to human mouse associations.



The Mammalian Behaviour Ontology is needed in order to provide unambiguous descriptions of behaviours which can be used in the postcomposed EQ representation of phenotypes. A current challenge in the description of phenotypes is distinguishing between the directly observed phenotype and the inferred phenotype, with additional biological meaning, made after expert analysis. The MBO makes this distinction with the categorisation of phenotypes as either direct behavioural activities or inferred behavioural functions.

This process of developing the MBO will rely on contributions from experts from within both the animal behaviour and ontology communities. Please register your interest with getting involved in this project by e-mailing: t.beck@har.mrc.ac.uk.

References and Acknowledgements

¹ Mallon AM, Blake A, Hancock JM: EuroPhenome and EMPReSS: online mouse phenotyping resource. Nucleic Acids Res 2008, 36(Database issue):D715-718. ² Beck T, Morgan H, Blake A, Wells S, Hancock JM, Mallon AM: Practical application of ontologies to annotate and analyse large scale raw mouse phenotype data. BMC Bioinformatics. 2009, 10(Suppl 5):S2. ³ Animal Behaviour Ontology Development: http://ontogenesis.ontonet.org/moin/AnimalBehaviourOntologyDevelopment.

This research was funded as part of the EUMODIC project (funded by the European Commission under contract number LSHG-CT-2006-037188). Thanks to the UK Medical Research Council for support and also to Hilary Gates and George Gkoutos for helpful contributions.