DTU

Modeling & Analysis
Poster: 915
AbsTrak: 18680
Appearance: 906

The Brede database: a small database for functional neuroimaging

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Abstract

The "Brede database" provides data for novel information retrieval techniques and automated meta-analyses in functional neuroimaging.

The complete database is available on the Web in XML and Matlab format. Results from automated analyses are also available on the Web.

Matlab programs are available in the "Brede neuroinformatics toolbox" for analysis and visualization of the data.

Brede neuroinformatics database

Main component: Data from scientific articles reporting Talairach coordinates:

- Cognitive functional neuroimaging experiments (majority)
- Lesion, spatial neglect
- Morphometry, London taxi drivers
- Pathological changes, Alzheimer's disease

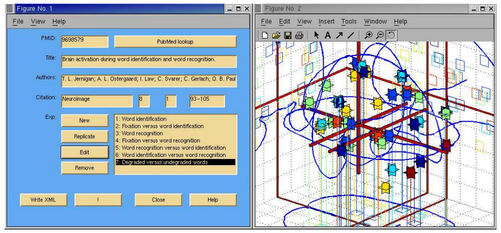
"Poor man's XML" (pXML, with no attributes and no empty tags): Database kept in a simplified version of XML, distributable on the Internet

Linked to other databases: PubMed, MeSH, SenseLab, fMRIDC.

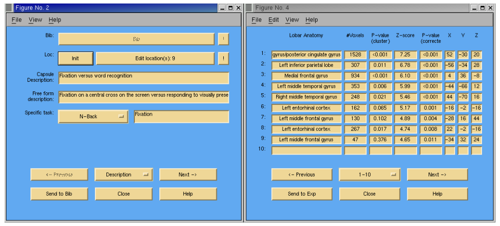
The database presently consists of data constructed from 85 scientific articles, containing 276 experiments and 1842 locations

Database components

The database is inspired by the hierarchical structure of BrainMap [1] with scientific articles ("bib" structures) on the highest level containing one or more experiments ("exp" structure", corresponding to a contrast in general linear model analyses), these in turn comprising one or more locations ("loc" structures).



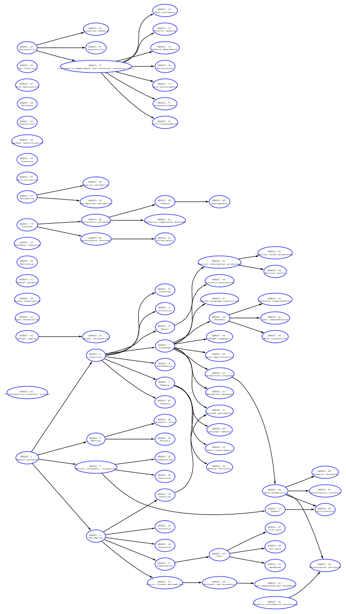
The information on the "bib" level (author, title, ...) is setup automatically from PubMed while the rest of the information is entered manually in a Matlab graphical user interface.



On the "loc" level this includes the 3D stereotactic coordinates in either Talairach or MNI space, the brain area (functional, anatomical or cytoarchitectonic area) and magnitude values such as Z-score and P-value.

Contextual markup

On the "exp" level information such as modality, scanner and behavioral domain are recorded with "external components" (such as "face recognition", "kinetic boundaries", "Alzheimer's disease" or "BZ site GABA-A receptor") organized in a directed graph.



The external components correspond to MeSH terms (NLM Medical Subject headings) and are linked to MeSH where equivalent items exist. There are presently 284 external components.

Voxel-based analysis

Voxelization: The locations for each "exp" and "bib" structure are voxelized to a volume by convolving each location with a Gaussian kernel [8, 11].

The voxelization equation for a specific experiment e from its set of locations $\{\mathbf{x}_l : l \in \mathcal{L}_e\}$ is

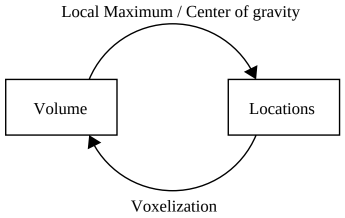
$$p(\mathbf{x}|e) = \sum_{l \in \mathcal{L}_e} (2\pi\sigma^2)^{-3/2} \exp\left[-\frac{(\mathbf{x}-\mathbf{x}_l)^2}{2\sigma^2}\right] P(l),$$

where there is a equal weighting over locations $P(l) = 1/|\mathcal{L}_e|$ and the kernel width is fixed at $\sigma =$ 1cm. Alternatively, it can be optimized with leave-one-out cross-validation [8]. The voxelization for a specific "bib" item b is constructed as the average over its "exp"

$$p(\mathbf{x}|b) = \sum_{e \in \mathcal{E}_b} p(\mathbf{x}|e)\, P(e), \qquad (2)$$

with priors taken as uniform over experiments $P(e) = 1/|\mathcal{E}_b|$.

Voxelization can be regarded as the inverse operation of finding the maxima in an image:

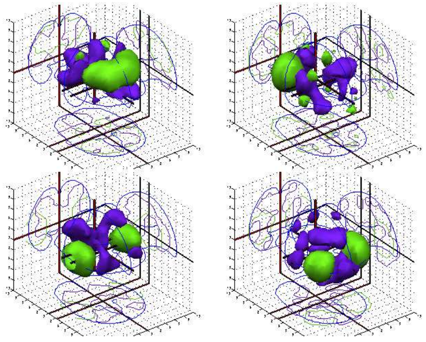


Automated analysis

Static web-pages are generated from the "exp" and "bib" structures with Corner Cube visualization [10] as PNG and VRML files and hyperlinks to PubMed and fMRIDC [12].

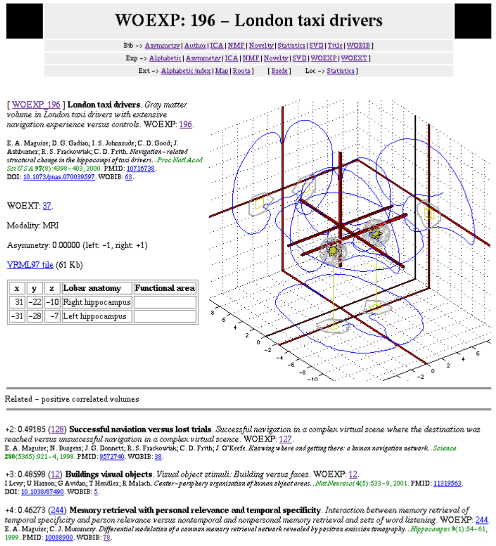
The combined set of volumes are converted to matrices and the following analyses are perform automatically:

- **Multivariate analyses** are performed such as singular value decomposition (SVD), independent component analysis (ICA) and non-negative matrix factorization (NMF) [4].



- **Finding related volumes**: Sorted lists with related volumes are found for each individual volume as well as with respect to the SVD eigenimages and the results of the ICA and NMF [9].
- **Asymmetry**: Counting the number of locations in left and right hemisphere and comparing the counts to a binomial distribution gives a laterality index.
- **Novelty**: Comparing each volume to mean or nearest volume gives an estimate of novelty or "outlierness": How different a volume is from the rest.

Example entry



WOEXP: 196 – London taxi drivers

Bib -> Asymmetry | Author | ICA | NMF | ...
Exp -> Alphabetic | Asymmetry | ICA | NMF | ...
Ext -> Alphabetic index | Map | Roots]

[WOEXP_196] **London taxi drivers**. *Gray matter volume in London taxi drivers with extensive navigation experience versus controls*. WOEXP: 196.

E. A. Maguire; D. G. Gadian; I. S. Johnsrude; C. D. Good; J. Ashburner; R. S. Frackowiak; C. D. Frith. *Navigation–related structural change in the hippocampi of taxi drivers.*. *Proc Natl Acad Sci U S A* **97**(8):4398–403, 2000. PMID: 10716738. DOI: 10.1073/pnas.070039597. WOBIB: 63.

WOEXT: 37.

Modality: MRI

Asymmetry: 0.00000 (left: −1, right: +1)

VRML97 file (61 Kb)

x	y	z	Lobar anatomy	Functional area
31	−22	−10	Right hippocampus	
−31	−28	−7	Left hippocampus	

Related – positive correlated volumes

+2: 0.49185 (128) **Successful naviation versus lost trials**. *Successful navigation in a complex virtual scene where the destination was reached versus unsuccessful navigation in a complex virtual scence*. WOEXP: 127.
E. A. Maguire; N. Burgess; J. G. Donnett; R. S. Frackowiak; C. D. Frith; J. O'Keefe. *Knowing where and getting there: a human navigation network.*. *Science* **280**(5365):921–4, 1998. PMID: 9572740. WOBIB: 38.

+3: 0.48598 (12) **Buildings visual objects**. *Visual object stimuli: Building versus faces*. WOEXP: 12.
I Levy; U Hasson; G Avidan; T Hendler; R Malach. *Center–periphery organization of human object areas.*. *Nat Neurosci* 4(5):533–9, 2001. PMID: 11319563. DOI: 10.1038/87490. WOBIB: 5.

+4: 0.46273 (244) **Memory retrieval with personal relevance and temporal specificity**. *Interaction between memory retrieval of temporal specificity and person relevance versus nontemporal and nonpersonal memory retrieval and sets of word listening*. WOEXP: 244.
E. A. Maguire; C. J. Mummery. *Differential modulation of a common memory retrieval network revealed by positron emission tomography.*. *Hippocampus* 9(1):54–61, 1999. PMID: 10088900. WOBIB: 78.

A web-page constructed from the "exp" entry (WOEXP: 196) of an experiment reported in [6] — a morphometry study of London taxi drivers: Listed with Talairach coordinates in the hippocampus and a Corner Cube visualization where the two locations are shown as glyphs together with an iso-surface as wire-frame in the volume from voxelization.

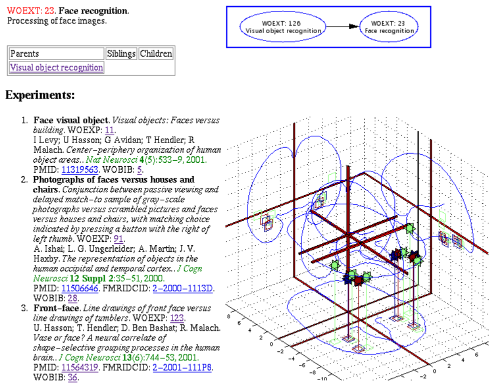
The first part of the list with related volumes are shown at the bottom.

Other features

Ad hoc search can obtain the closest locations to a user-specified coordinate or the closest experiments to a user-specified set of locations.

Items in the database are identified with unique numbers and the type of identifier is given a unique string, e.g., "WOBIB: 27" for an Epstein and Kanwisher paper, thus allowing Internet search engine to identify the phrase.

Example entry



WOEXT: 23. **Face recognition**.
Processing of face images.

Parents	Siblings	Children
Visual object recognition		

Experiments:

1. **Face visual object**. *Visual objects: Faces versus building*. WOEXP: 11.
I Levy; U Hasson; G Avidan; T Hendler; R Malach. *Center–periphery organization of human object areas.*. *Nat Neurosci* **4**(5):533–9, 2001. PMID: 11319563. WOBIB: 5.
2. **Photographs of faces versus houses and chairs**. *Conjunction between passive viewing and delayed match–to sample of gray–scale photographs versus scrambled pictures and faces versus houses and chairs, with matching choice indicated by pressing a button with the right of left thumb*. WOEXP: 91.
A. Ishai; L. G. Ungerleider; A. Martin; J. V. Haxby. *The representation of objects in the human occipital and temporal cortex.*. *J Cogn Neurosci* **12 Suppl 2**:35–51, 2000. PMID: 11506646. FMRIDCID: 2–2000–1113D. WOBIB: 28.
3. **Front–face**. *Line drawings of front face versus line drawings of tumblers*. WOEXP: 123.
U. Hasson; T. Hendler; D. Ben Bashat; R. Malach. *Vase or face? A neural correlate of shape–selective grouping processes in the human brain.*. *J Cogn Neurosci* **13**(6):744–53, 2001. PMID: 11564319. FMRIDCID: 2–2001–111P8. WOBIB: 36.

The "face recognition" external component (WOEXT: 23) with links to experiments marked up as "face recognition", here presently experiments from [5, 3, 2].

Availability

Database distributed as XML and Matlab files. Most recent update available from http://hendrix.imm.dtu.dk/services/jerne-/brede/.

Matlab programs for manipulating, analyzing and visualizing the data are available in the "Brede neuroinformatics toolbox" [7], http://hendrix.imm.dtu.dk/software/brede/.

Acknowledgment

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