Building a Database of Neural Functions: The Tabula Repository

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Features

Search functions

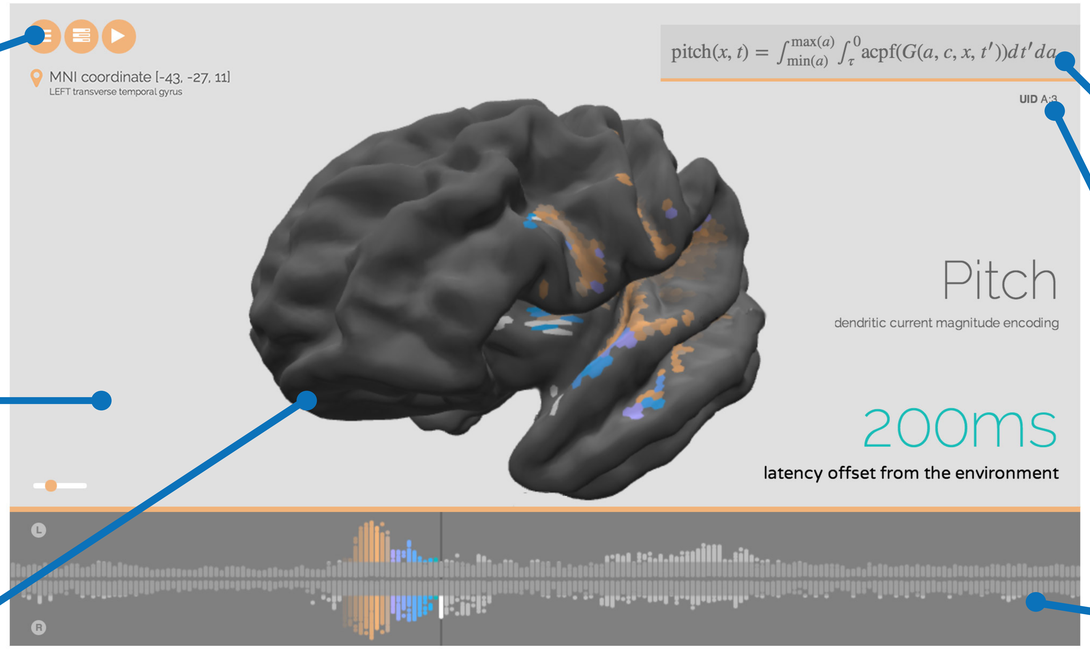
- By function name
- By tag
- By input stream

Accessibility

- Works on all HTML5-compliant browsers, using webGL
- Includes API that can be accessed by third-party developers

Visualisation

- Rotatable 3D cortex
- Regions of interest
- MNI coordinates



Models/ functions

- Includes pseudo-code
- Includes meta-data such as author, tag and reference

Citing tools

- Unique identifying code for each function
- Permalink to allow electronic sharing

Function Expression

- Evidence displayed as p-values over time
- Coloured by time to aid navigation

What functions are in it?

The Tabula repository currently holds the expression of roughly fifty functions. As more functions are uploaded, so the constraints on a potential computational blueprint will become more powerful. Also present in the database will be a listing of candidate functions for which no evidence has been found. Negative results are informative, and Tabula includes these functions so this information is retained.

Auditory function examples:

name	*description*	*author*
pitch	The fundamental frequency of the sound.	*various*
periodicity	The harmonic-to-noise ratio of the sound.	Kawahara & Morise, 2011
delta-pitch	The first derivative of the output of the pitch function.	*various*
loudness (ins)	The instantaneous loudness of a sound.	Moore, Glasberg & Baer, 1997
loudness (perc)	The perceptual loudness of a sound.	Glasberg & Moore, 2002

Visual function examples:

name	*description*	*author*
Horizontal movement	The average horizontal movement in the field of vision over the last 10ms.	Horn & Schunck, 1981
red component	The average 'redness' of the field of vision.	*various*
green component	The average 'greenness' of the field of vision.	*various*
blue component	The average 'blueness' of the field of vision.	*various*

Uploaded with the function's expression is its accompanying meta-data. This includes a unique identifier, a unique name, and a HTTP address of the complete formal description of the function in question (normally a published work).

Introduction and Methods

- We can characterise any hypothesis that involves information transfer in the brain as a mathematical function, or algorithm.
- The function makes predictions about how the brain will react to certain stimuli.
- We can use this to 'search' the cortex in space and time for the function (see next box)

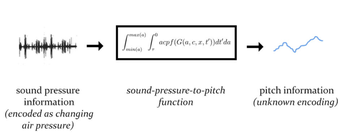


Figure 1: Transforms of information in the brain can be characterised as a mathematic function.

- We introduce a database, Tabula, which aims to make the precise spatiotemporal coordinates of neural functions available for general use in an unambiguous and statistically transparent way.
- The accompanying online viewer allows examination of function expression in an easy-to-use 3D format, with the possibility to export the data into in-house programs using the database's API.

Where does the data come from?

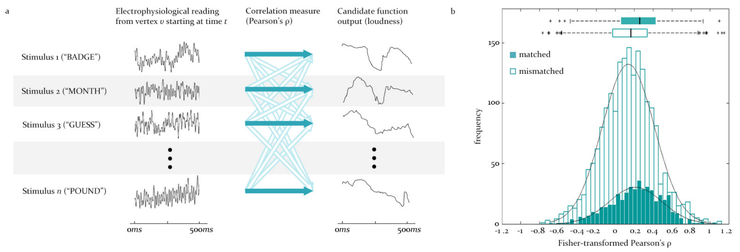


Figure 2: Testing for the presence of a function's output in a region of the cortex. This process is repeated for every source and latency of interest.

The presence or absence of each candidate function is established using a searchlight procedure (Thwaites et al., under review) which tests for evidence of the expression of the function in a 'source space' representation of whole brain neural activity, reconstructed from MEG+EEG recordings using Minimum Norm L2 techniques (Hämäläinen & Ilmoniemi, 1994).

Conclusions

- The database is aimed at neuroscience researchers who want to browse, cite and share the results generated by detecting the neural expression of functions.
- The database will be updated with additional functions at regular intervals.
- The database will eventually hold function expression from brains from across the age ranges, as well as from brains experiencing neurodegenerative diseases such as Alzheimer's and Parkinson's, allowing for the comparison of brain function between these groups.

References

Hämäläinen & Ilmoniemi (1994) Med. Bio. Eng. Comp. vol. 32. Horn and Schunck (1981) Art. Intel., vol 17, Kawahara & Morise (2011) Acad. Proc. Eng. Sci., Vol. 36, Moore, Glasberg & Baer (1997) J.Audio.Eng.Soc. vol 45, Glasberg and Moore (2002) J.Audio.Eng.Soc. vol 50

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