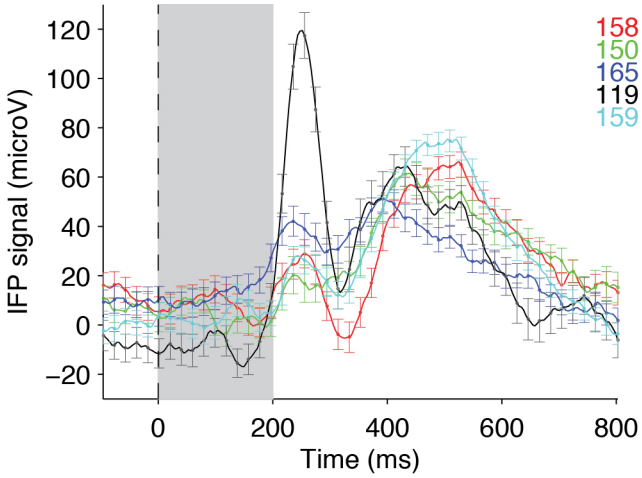
Kreiman Laboratory. Liu et al, Neuron 2009.



Liu H, Agam Y, Madsen J, Kreiman G. (2009) Timing, timing, timing: Fast decoding of object inforrmation from intracranial field potentials in human visual cortex. Neuron 62:281-290.

You can download a PDF of this publication here:
http://klab.tch.harvard.edu/publications/publications.html
There are multiple analyses that did not fit into the paper and can be accessed here:
http://klab.tch.harvard.edu/resources/timing_timing_timing/index.htm
(note that this extends the supplementary material accompanying the paper).

There are four folders:

(1) Intracranial field potential recordings
(2) Electrode locations
(3) Images
(4) Code

Details about the experimental procedures are provided in the above mentioned publications (Liu et al, Neuron 2009).

Stimulus presentation
Duration: 200 ms
Position: Centered on the screen
Size: ~1.5, 3 or 6 degrees of visual angle
Viewpoint: 0, 45 and 90 degrees rotation (see Images folder)
Task: One-back task
Presentation order: pseudorandomized

(1) Intracranial field potential recordings

Folder name = IFP
There is one subfolder per subject

File names:
`info_subj<subject_number>.mat`
`data_subj<subject_number>_exp<e1>to<e2>_t<t1>to<t2>.mat`

Example:

```
load info_subj10.mat
n_channels      1x1                 8  double  [number of channels]
n_sessions      1x1                 8  double  [number of sessions]
n_trials        1x1                 8  double  [number of trials]

load data_subj10_exp1to2_t100to800_sa1.mat
d_all           1x88             562646656 cell
expid           1776x1           14208     double
p_all           1776x14          198912    double
responses       1776x1           1776      logical
t               1x450            3600      double
```

t: time (ms) from -100 to +800 ms with respect to stimulus onset. The interval between time points depends on the sampling rate for the experiment.
responses: 1 (correct) and 0 (incorrect) for each trial.
The % correct is `100*sum(responses)/length(responses).`
expid: session ID for that trial. If there were multiple sessions, data were concatenated. This entry indicates which session each trial came from. The data in Liu et al (2009) involved merging all sessions. For analyses regarding the stability across sessions, see Bansal et al (2012).
d_all: data for each electrode and trial

```
n_channels=length(d_all);     % number of channels
data1=d_all{1};whos data1     % data for channel 1
data1      1776x450            6393600  double
[n_trials,n_timepoints]=size(data1);
```

`data1(i,j)` indicates the voltage (microvolts) for channel 1 at time j.
The sampling rate is `length(t)/(800+900)ms` (in this case, 500 Hz)
p_all: information about stimulus presented in each trial
col1 = index in image_info_list (See "Images").
col2 = repetition for that particular image
col3 = object 1. Number between 1 and 33 identifying the object; only 25 objects shown in experiment. (See "Images").
col4 = Ignore. object 2. In this case, this is 0. (This variable was used when presenting two objects in the display in Agam et al 2010.)
col5 = category 1. Category 1, 2, 3, 4, 7 (5 categories in this experiment).
col6 = Ignore. category 2. In this case, this is 0.
col7=id1. Exemplar number within each category from 1 to 5.
col8=Ignore. id2. In this case, this is 0.
col9 = size1. Size 1 (1.5 degrees), 2 (3 degrees) or 3 (6 degrees)
col10 = Ignore. size2. In this case, this is 0.
col11 = rotation1. Rotation 1 (0 degrees), 2 (45 degrees) or 3 (90 degrees)
col12 = Ignore. rot2. In this case, this is 0.
col13 = Ignore. up/down information. Only relevant when presenting two objects.
col14 = Ignore. left/right information. Only relevant when presenting two objects.
The combination of col5 (category), col7 (identity), col9 (size) and col11 (rotation) specifies the stimulus. There is also a redundant identified in col1.

(2) Electrode Locations

The subdural recordings are parcelated according to the following methods and nomenclature:
Dale, A. M., Fischl, B. & Sereno, M. I. Cortical surface-based analysis. I. Segmentation and surface reconstruction. *Neuroimage* **9**, 179-194 (1999).
Fischl, B. *et al.* Automatically parcellating the human cerebral cortex. *Cereb Cortex* **14**, 11-22 (2004).
Destrieux, C., Fischl, B., Dale, A. & Halgren, E. Automatic parcellation of human cortical gyri and sulci using standard anatomical nomenclature. *Neuroimage* **53**, 1-15 (2010).

File names:
`electrode_locations_subj<subject_number>.mat`
There is one file per subject

Example:

```
load electrode_locations_subj10.mat
whos
  Name                Size             Bytes  Class     Attributes
  channels           67x1                536  double
  hemisphere          1x67               568  double
  region_codes       67x1                536  double
  regions            67x1               9636  cell
  talairach          88x3               2112  double
  volumeind          67x3               1608  double
```

`length(channels)` = number of electrodes mapped
`channels` = map onto data channels and positions in the electrode recording setup
Note: some channels may not be mapped onto a location and therefore there may be fewer entries here compared to the data files. This variable relates the data onto the mapped locations.
`hemisphere` = 1 for right hemisphere and 2 for left hemisphere
`region_codes` = number between 1 and 75 indicating the electrode location based on parcellation of the surface into 75 regions.
`regions` = region names
`volumeind` = volume coordinates used in mapping software
`talairach` = Talairach coordinates
As described above, there may be more electrodes in the data and in Talairach than in all the other variables because some of those electrodes were not mapped onto the parcellated regions.

(3) Images

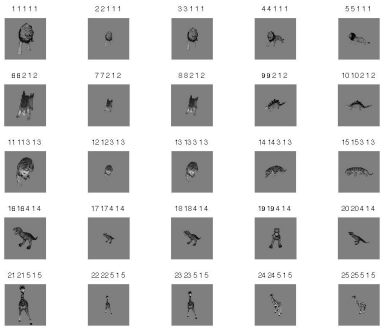
```
load image_info_list.mat

image_info_list      201x12            19296  double
image_name_list      201x2             75182  cell
```

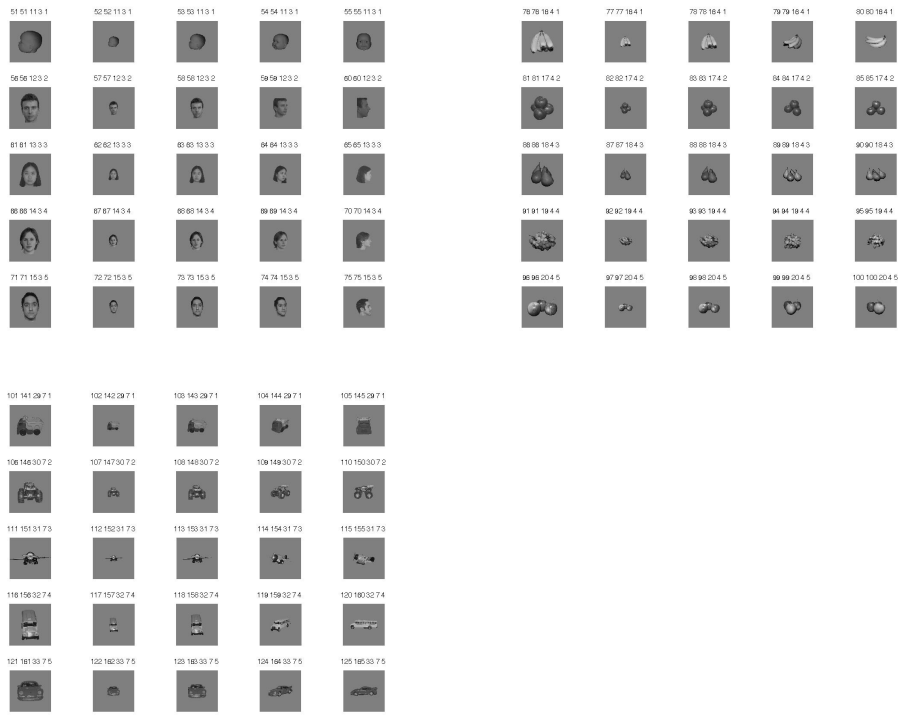
`image_info_list`
(information similar to that contained in p_all)

Column	Variable	Values	Notes
1	Obj1	1-33	Object identifier (only 25 objects shown in experiment.
2	Obj2	0-13	Ignore
3	Cat1	1-7	Category for object
4	Cat2	0-3	Ignore (only relevant in 2-object case)
5	Id1	1-5	ID within category
6	Id2	0-3	Ignore (only relevant in 2-object case)
7	Size1	1-3	Size
8	Size2	0-1	Ignore (only relevant in 2-object case)
9	Rot1	1-3	Rotation
10	Rot2	0-1	Ignore (only relevant in 2-object case)
11	Up/down	0-2	Ignore (only relevant in 2-object case)
12	Left/right		Ignore (only relevant in 2-object case)

`image_name_list`
column1: image name
column2: ignore

The following images show the 25 objects, each at 3 scales and 3 rotations. Note that the images are not drawn to scale. The numbers above each image indicate the ID, category, exemplar, size, rotation.





(4) Code
This folder contains code that creates Fig. 1A in Liu et al 2009. This should help understand the different variables and how they are used.
Usage:
`ifp_plot_rawdata;`

For this code to work, you will need to edit the path to where the data are stored. The default path is indicated in the variable `gdat_dir` within `default_params.m`