ChatGPT

Macaque Brain Regions in Social Competition Task

Neurophysiological recordings during the *Social Competition Task* (a competitive “food-grab” paradigm) show that multiple cortical and subcortical areas encode the monkeys’ dominant vs. submissive social state. In particular, **lateral prefrontal cortex (PFC)** neurons fire more strongly when a monkey is dominant and are suppressed when it is subordinate [1]. Likewise, **posterior parietal cortex** and **sensorimotor regions** (primary somatosensory and motor cortex, including premotor areas) carry sustained information about social hierarchy before an action is taken [2] [3]. As the competition becomes explicit (food appears), **visual cortex** and additional PFC neurons show buildup of dominance/submission signals [2] [3]. Subcortically, the **dorsal striatum (caudate nucleus)** also tracks social context: caudate neurons increase activity during food presentation when a monkey is dominant, but decrease (become quiescent) when it suppresses its behavior in the subordinate role [3]. Thus, a distributed network – including lateral PFC, parietal/sensorimotor cortex, visual cortex and basal ganglia – differentiates dominant vs. submissive behavior in macaques. These findings are supported by NeuroTycho data and related publications [2] [1] [3].

Human Analogs of Macaque Social Regions

Many of the same brain areas have human counterparts that have been implicated in social hierarchy. In humans, the **dorsolateral prefrontal cortex (dlPFC)** plays a key role in encoding one’s rank: fMRI studies show that viewing or interacting with higher-status individuals engages human dlPFC (homologous to macaque PFC) and related executive networks [4]. Likewise, the **posterior parietal cortex and sensorimotor regions** have direct homologs in humans (e.g. intraparietal sulcus and pre/post-central gyrus) that support social attention and action planning. Visual areas (e.g. primary visual cortex) are conserved across primates and similarly process relevant cues. Subcortically, the **striatum (caudate nucleus)** and **amygdala** in humans participate in tracking social status and reward. For example, neural circuit analyses in macaques (Noonan *et al.*) highlight that amygdala and striatal volumes correlate with dominance [5]; these limbic and basal ganglia structures have direct human analogs involved in social valuation. In sum, the macaque networks map onto analogous human networks: human dlPFC, parietal cortex, sensory-motor cortices, visual cortex, and basal ganglia (striatum/amygdala) are all engaged by dominance and hierarchical behavior [1] [4].

Visualization Tools and Example Code

Several open-source Python packages can render 3D brain regions. For example, **nilearn** (for volumetric/MRI-based plots), **pycortex** (for interactive surface plots), and **brainrender** (for 3D atlas-based rendering) support highlighting regions of interest. Below is an example using **brainrender** to visualize schematic dominant (red) vs. submissive (blue) regions on 3D brain models. (In a real analysis one would load specific atlas regions or subject data; here we illustrate with simple markers at representative coordinates. The viewer can be rotated with keyboard arrows.)

```
# Example: Brainrender visualization of 'dominant' vs 'submissive' regions (red vs blue).
# Requires: pip install brainrender (Ubuntu 24.04, CUDA 12.4, suitable drivers).
from brainrender.scene import Scene
from brainrender.actors import Point

# Human brain scene (Allen Human Brain atlas)
scene_h = Scene(atlas_name='allen_human_500um', title='Human Brain – Dominant (red) vs Submissive
# Add markers for illustrative loci (e.g. approximating dlPFC vs visual cortex)
scene_h.add(Point((0, 50,  20), color='red',   radius=4, name='Dominant-reg'))
scene_h.add(Point((0,-80,  10), color='blue',  radius=4, name='Submissive-reg'))
scene_h.render()  # opens an interactive 3D window; use arrow keys to rotate

# Macaque analog scene (using same template as placeholder)
scene_m = Scene(atlas_name='allen_human_500um', title='Macaque Analog – Dominant (red) vs Submiss
# Slightly shifted markers to suggest different coordinates
scene_m.add(Point((5, 45,  15), color='red',   radius=4))
scene_m.add(Point((5,-75,   5), color='blue',  radius=4))
scene_m.render()
```

This code uses **brainrender** to display two brain models. In practice, one could substitute a macaque atlas or custom mesh for the macaque scene. The red and blue points mark regions analogous to macaque dominance signals (e.g. PFC) versus submissive signals (e.g. sensory areas). The scenes are interactive: pressing the left/right arrow keys rotates the brain, allowing viewing of the highlighted regions.

Sources: Macaque ECoG studies [2] [1] [3]; human hierarchy fMRI [4]; brainrender documentation.

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   https://pubmed.ncbi.nlm.nih.gov/18633840/

2. 3. **Social Suppressive Behavior Is Organized by the Spatiotemporal Integration of Multiple Cortical Regions in the Japanese Macaque | PLOS One**
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4. **Know Your Place: Neural Processing of Social Hierarchy in Humans - PMC**
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5. **A Neural Circuit Covarying with Social Hierarchy in Macaques | PLOS Biology**
   https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1001940