PPC

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1 Connection

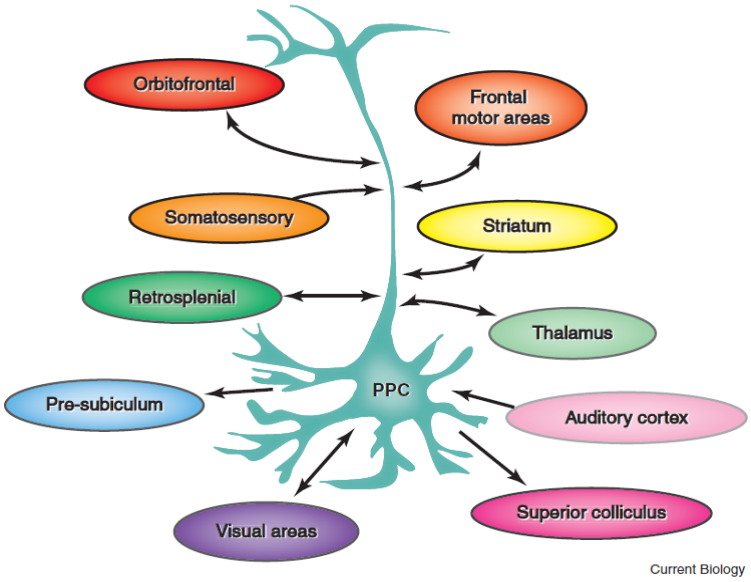

Figure 1: "Cortical and sub-cortical connections of posterior parietal cortex. Shown in schematic form, a given neuron in posterior parietal cortex can receive input and send output to a large number of areas in different systems of the brain. The diversity of connections speaks to the variety of behaviors in which posterior parietal cortex participates, including decision-making, spatial attention, working memory, movement planning, navigation, as well as processing visual, somatosensory and auditory signals."[1]

1.1 Input

- sparse input from the parahippocampal region (including entorhinal cortex) but not the hippocampal formation. However, studies shows that the spatial encodings in PPC is independent from enrorhinal cortex. [2].
- from lateral dorsal/posterior thalamus nuclei [3].
- reciprocal connections with premotor cortex, frontal visual fields, and several paralimbic areas [3].

Note: Comparing to the anterior parietal cortex, the PPC perform "higher-order functions" whereas the former one mainly consist of primary somatosensory areas. PPC is "neither strictly sensory nor motor", but integrates information of somatosensory, visual, auditory, motor, etc., and both vestibular and proprioceptive inputs from subcortical regions.[1]

1.2 Output

- to RSC: moderately connected
- to dorsal presubiculum: moderately connected
- sparce projections to rostral perirhinal cortex, postrhinalcortex, caudal entorhinal cortex and parasubiculum

1.3 Main Components

"The posterior parietal cortex can be subdivided into the superior parietal lobule (Brodmann areas 5 + 7) and the inferior parietal lobule (39 + 40), separated by the intraparietal sulcus (IPS). The IPS and adjacent gyri are essential in guidance of limb and eye movement. IPS is further divided into medial (MIP), lateral (LIP), ventral (VIP), and anterior (AIP) areas based on cytoarchitectural and functional differences."[4]

2 Function

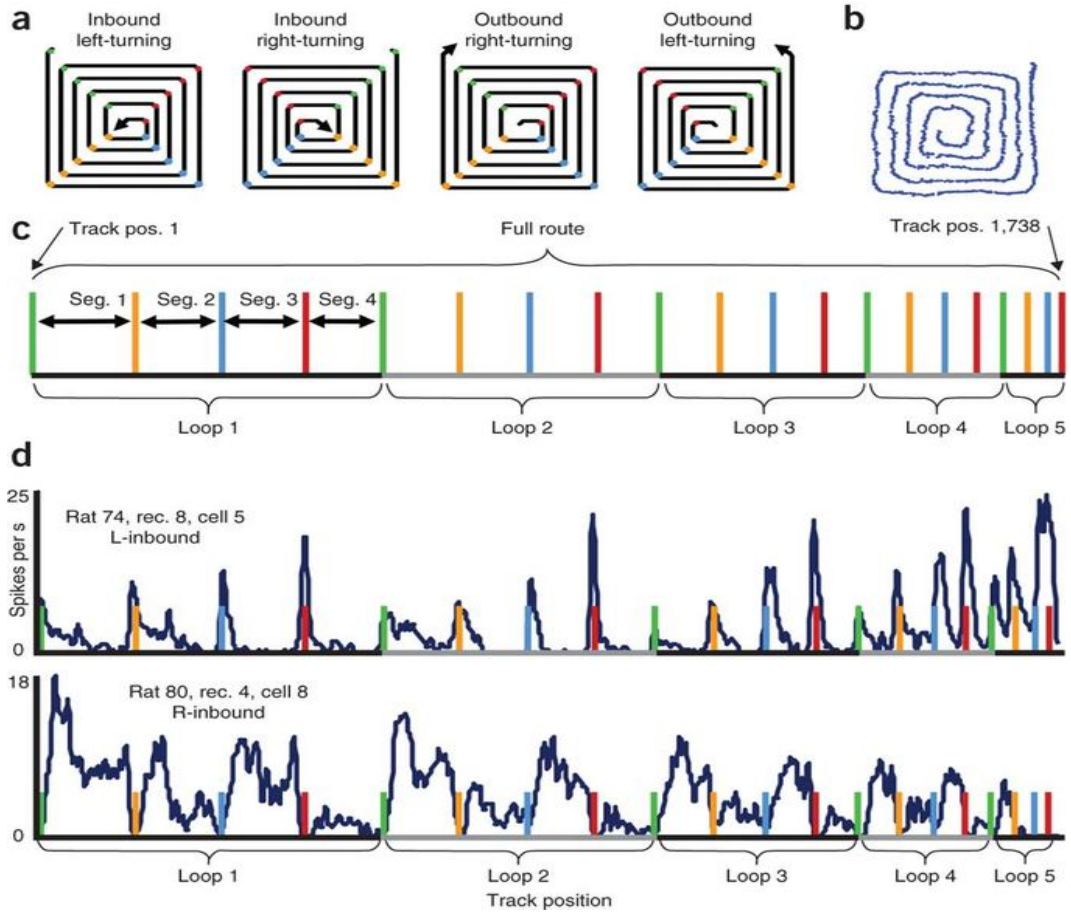

Figure 2: "(a) Schematics for the routes used in a study. Filled circles mark turn sites and map to the vertical lines in c. (b) Example tracking data for the right-inbound path. (c) Tracked positions were mapped to a template of each track. Position 1 corresponds to the outermost position; position 1,738 corresponds to track center. Colored vertical lines correspond to turn sites. (d) Top, linearized firing of a PPC neuron bearing multiple activity peaks at track positions associated with left turns. Bottom, a second PPC neuron having a more commonly observed complex firing pattern." [5]

- Route Cells: the firing patterns of route cells are preserved when the route is in different locations of allocentric environment[6]. The firing can be compressed or expanded in size with the change in the scale of the route, and does not totally rely on light.[7, 5]. And the route cells behave similarly even when the rats only run in northsouth sequences in an open arena rather than a real maze consisting of northsouth alleys [8].
- Head Direction Cells: comparing to the head direction cells in RSC, the one in PPC is less sharply directionally tuned and more modulated by behavior or egocentric reference frame. 57% of PPC head direction cells has the directional firing pattern associated with specific steering behaviors. [9, 2].
- Egocentric Cue Cell: encodes the location of a distal visual cue relative to the rat's position. Some are pure egocentric cue direction cell, some are conjunctive with the distance to the cue or the head direction. This indicates that PPC's role in the translation from egocentric to allocentric reference frame [10].

- Self Motion Cell: enodes left/right-steering, and straight-running behaviors. It is unclear whether they are based on visual signal, vestibular sensory, proprioceptive input or motor efference copy.[11, 10]
- Movement Planing: Both the conjunctive ECD with head direction cells and the self motion cells have a subpopulation firing before movement, sometimes even 1s in advance [10, 2]. It was found that the patients with PPC damage could not mentally navigate among familiar locations, but can remember details of those locations [12].
- Imitation and mirror neurons: patients with damaged PPC had difficulty inpantomiming how to use different objects, e.g. hammering a nail, no matter the instruction was verbal or visual, though they had no problem using a real hammer or recognizing the movements performed by others. Also the mirror neurons were found to fire "whether a particular action is made or merely observed, sometimes modulated by the end-goal of that action." [1]

Because of its complex connectivity as shown in Figure 1, different parts of PPC participate in different cognitive processes e.g. directed attention, decision making, working memory, and "it also mediates some abstract and symbolic cognitive capacities, including the representation of real and imagined spatial relationships, as well as numerical quantity and mathematical abilities". [1]

2.1 Scales

- Spatial Scales: the space related cells can operate on multiple scales as discussed in session 2.
- Temporal Scales: anticipatory alpha rhythms is shown to modulate the control of visuo-spatial attention[13].

2.2 Evidence of Building Blocks / Modularization

The route cells is an good example of building blocks - it recognize a route even when it is in different locations with different scales.

2.3 Evidence of Lateralization

- Around 33% of the patients with left-side damaged PPC shows hemispatial neglect, while more than 50% in right-hemisphere damaged patients [14, 3].

2.4 Empirical Lesion studies

- Rats with lesion of PPC were impaired to navigate based on proximal landmarks but had no problem in navigating by distal landmarks or the goal only. [15].
- Patients with damaged PPC exhibited the Blints syndrome, for example, he/she could locate a project and look at it, also name it, but not grasp it, which showed that PPC was "critical to the construction of a map of peripersonal space and the coordination of actions in it".[1]
- PPC lesion often lead to the loss of body part awareness, e.g, body posture, limb positions. A few patients exhibited autotopagnosia (cannot correctly locate a body part when being instructed), and some totally lost body part awareness, often the fingers. [16, 17, 1]

3 Computational Model

N/A

References

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