补充-1
导航
Supplementary-1
Navigation

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导航中的计算
Computation in Navigation

- 什么是导航呢？通俗地讲，就是从A地到B地；我们生活中讲导航，侧重于当我们访问没有去过的地方时，怎么找到路。

  What's navigation? In Plain text, it is just to go from A to B. However, if we talk about navigation in daily life, it emphasizes on find a way to the place we never visit before.

- 导航从本源上来讲，起源于生物行为，此对于生物的生存意义重大；在生物的觅食、交配、迁徙等行为中，不可或缺。虽然，对于人类而言，有额外的手段，如罗盘、GPS来辅助导航，但动物并没有这些东西；动物可以利用环境线索、本能来导航，但探究导航的神经学计算模型和模式，还是非常有意义的。

  Navigation originates from animals' behavior, which plays a vital role in their survivals. Navigation is inevitable during their foraging, mating and migrating. Although for human beings, there are tools such as compass, GPS to aid the process, but the animals are without such facilities. Instead, the animals can use the environmental cues, instincts, etc., to navigate. Nevertheless, to research into the computation model and paradigm is of great meaningfulness.

导航中的计算
Computation in Navigation

- 我们先从计算机的角度，来回忆一下，例如，利用计算机导航，需要哪些步骤：

  First, we recall the procedures of utilizing GPS to navigate from the machine's perspective

  - 需要存储关于目标地区的地图（Store a map of the targeted area）
  - 利用如图像处理或计算机视觉等手段，辨识中出街道与十字路口（Segment out the street and cross via techniques such as image processing and computer vision）
  - 标识出关键点（Anchoring the key points）
  - 转化为图应用问题（Converting to graph applications）
  - 根据GPS信号对位置信息进行实时同步（Real time location synchronization by GPS signal）
  - 比较目的位置看是否已经完成导航（Comparing with destination）

空间表示
Spatial Representation

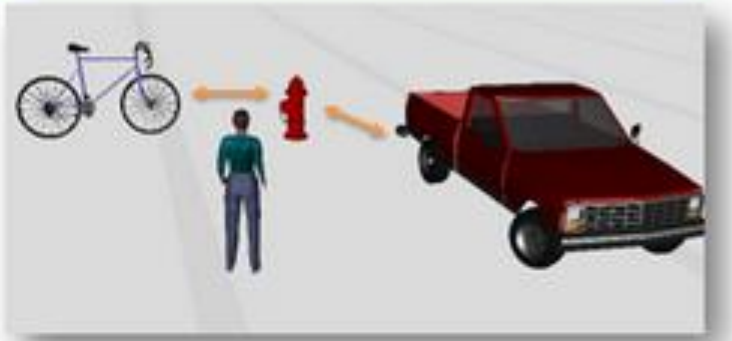
- 以自我为中心的空间表征（egocentric spatial representations）
  - egocentric /ˌɛgə(ʊ)ˈsɛntrɪk/ adjective, centred in or arising from a person's own individual existence or perspective.
  - used to guide wayfinding to locations in a person’s immediate environment by relating spatial information to the body of the individual
- 以周遭为中心的空间表征（allocentric spatial representations）
  - allocentric /ˌalə(ʊ)ˈsɛntrɪk/ adjective, concentrating on or interested in external objects in themselves, rather than in regard to their relation or relevance to oneself.
  - used to guide wayfinding to locations outside of a person’s immediate environment by using long-term memories about the arrangement of environmental landmarks independent of a person’s actual location.

空间表示
Spatial Representation

Spatial Coding Systems

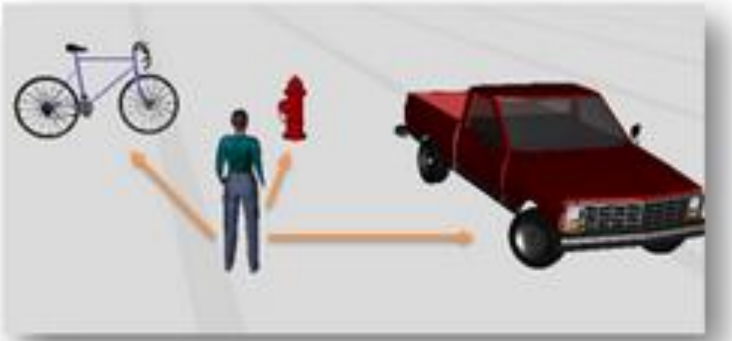
Allocentric (object-to-object)

Encodes information about the location of one object or its parts with respect to other objects. The location of one object is defined relative to the location of other objects.



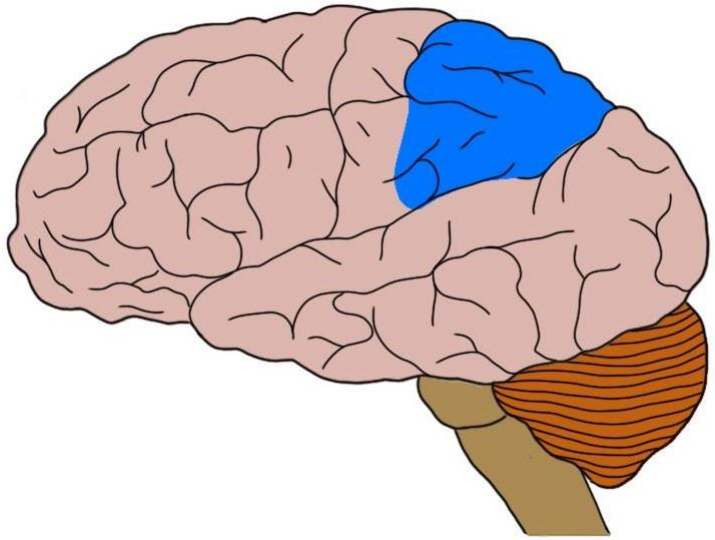
Egocentric (self-to-object)

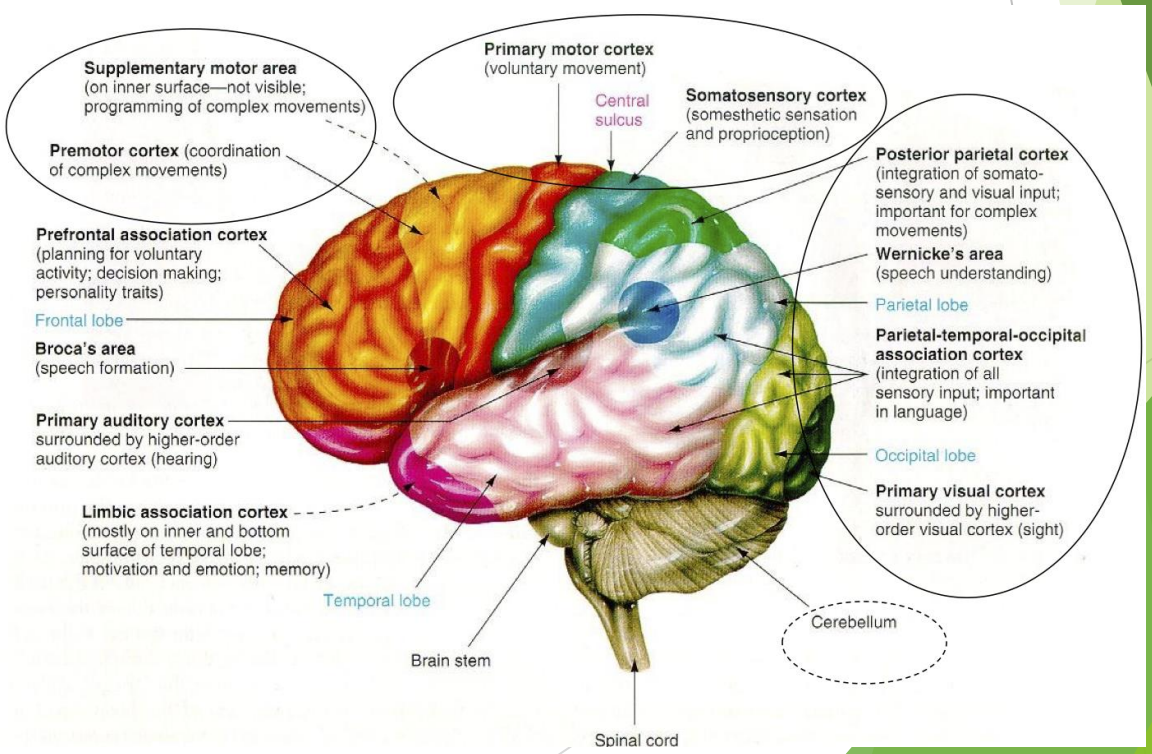
Represents the location of objects in space relative to the body axes of the self (left-right, front-back, up-down).



对应不同表征功能的脑功能区
Corresponding Brain Functioning Locations

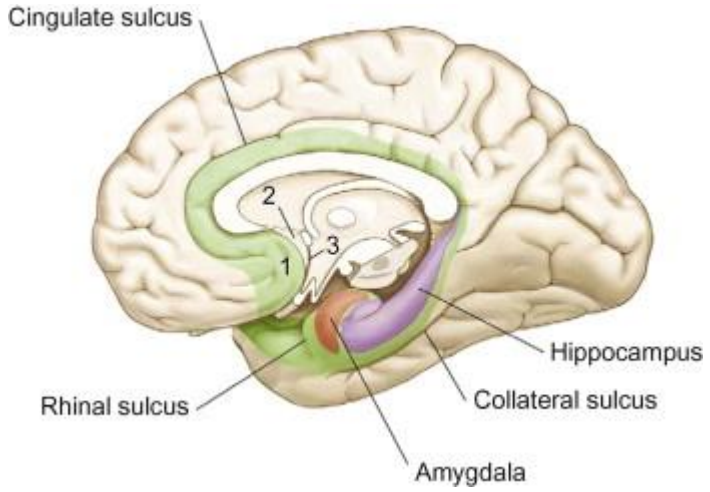
- Posterior parietal cortex (PPC) is the primary cortical area involved in generating and maintaining the egocentric spatial representations used for navigation (Burgesset al., 2001; Byrne et al., 2007).

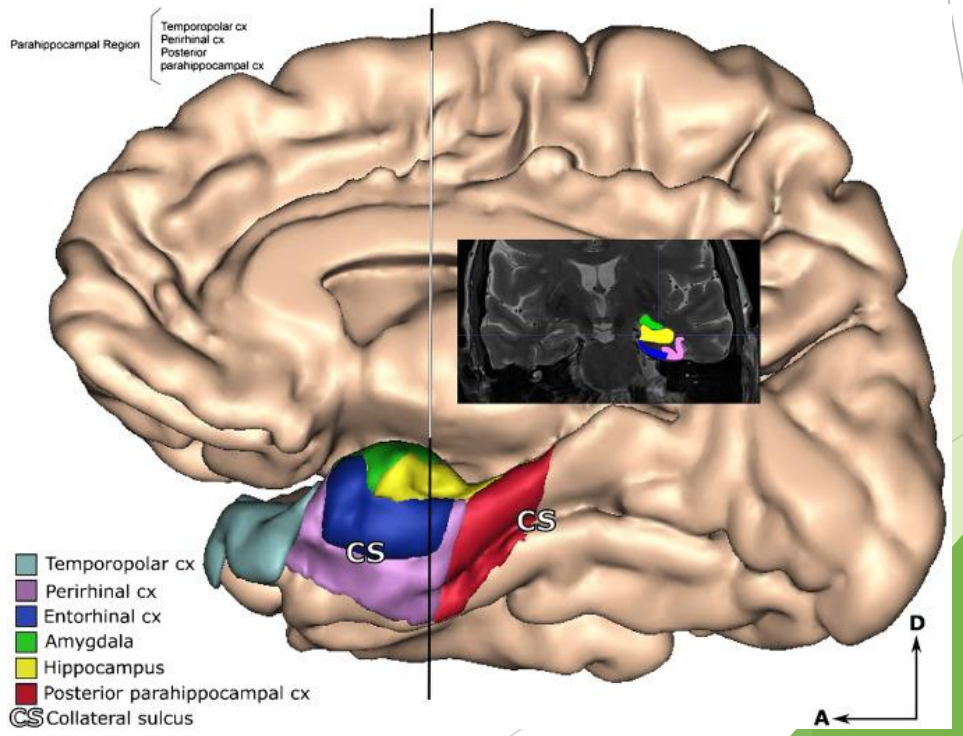




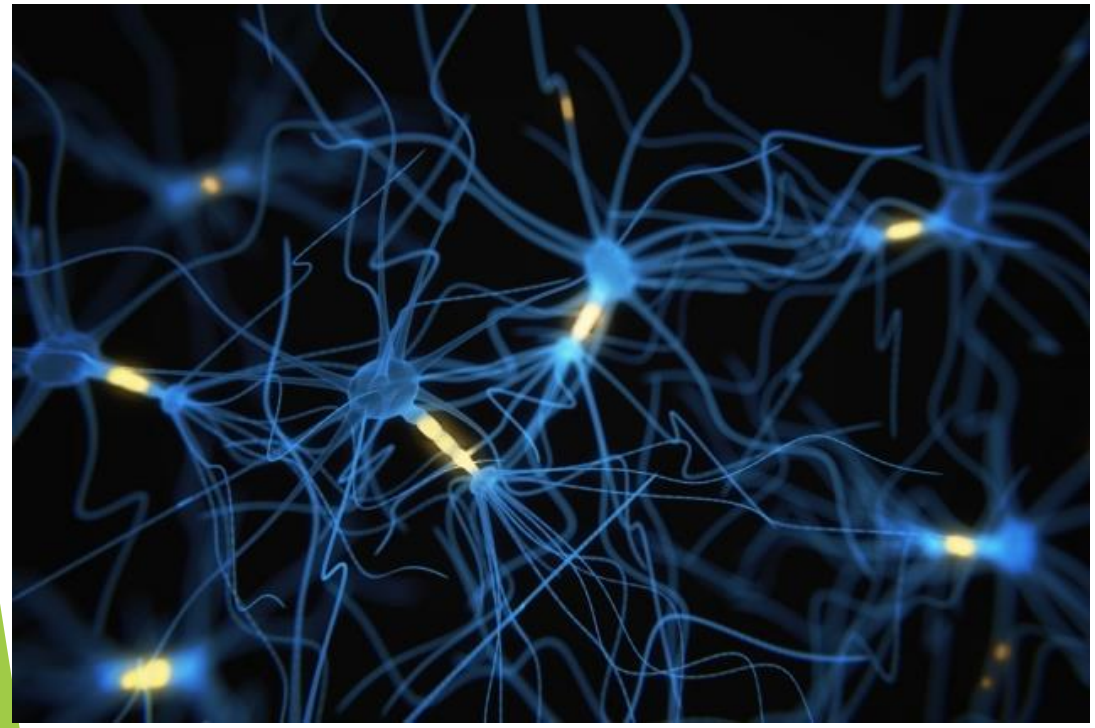
对应不同表征功能的脑功能区
Corresponding Brain Functioning Locations

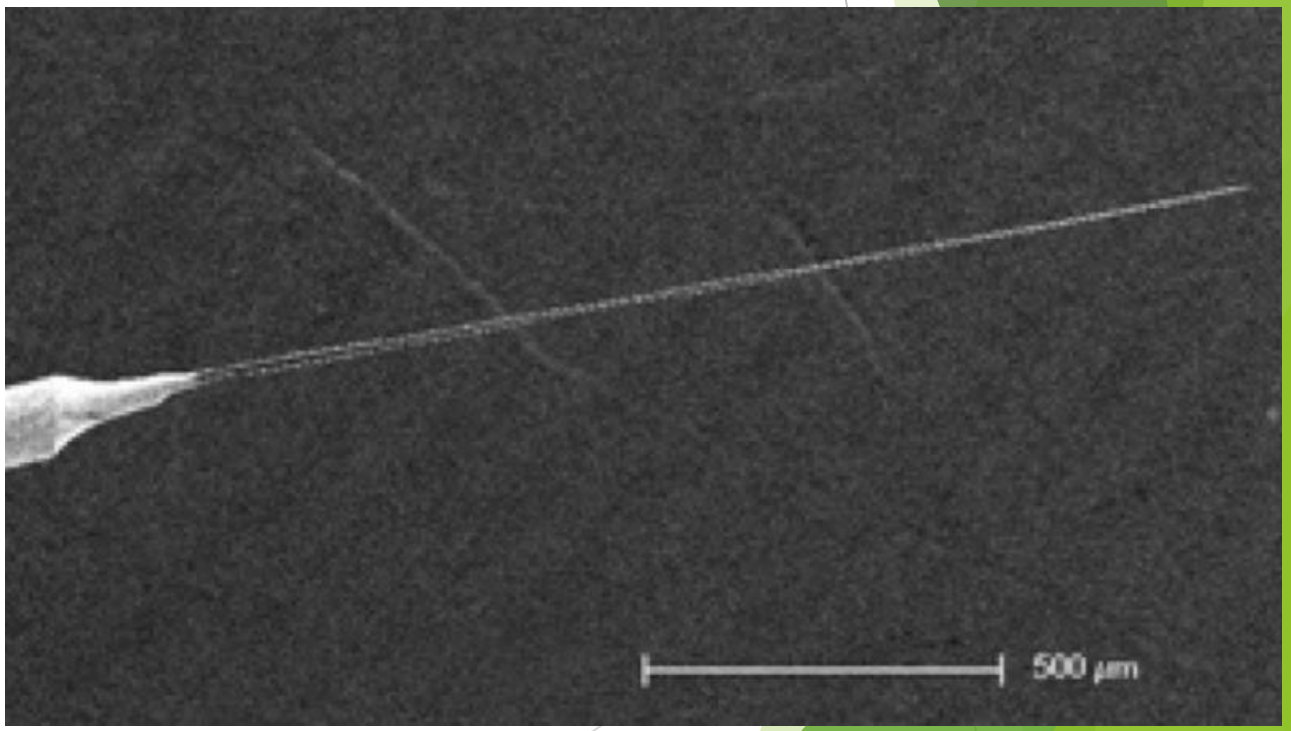
- Allocentric Spatial Representations Are Processed in the Medial Temporal Lobe, via the effective integration of various types of neurons in the medial temporal lobes



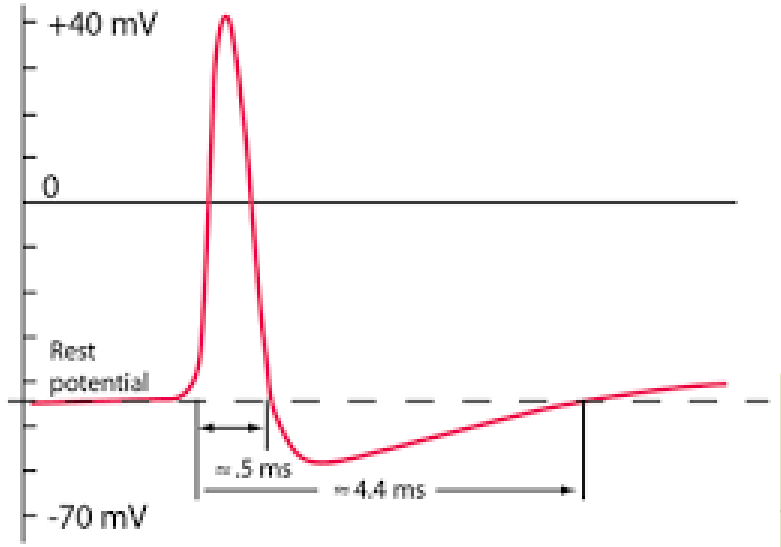


神经元活动及探测
Neuron Activities and Probe





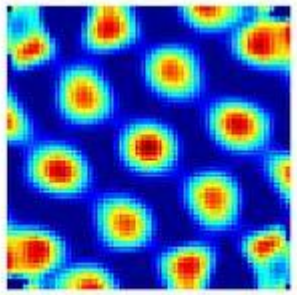
实验设置
Experiment Setup

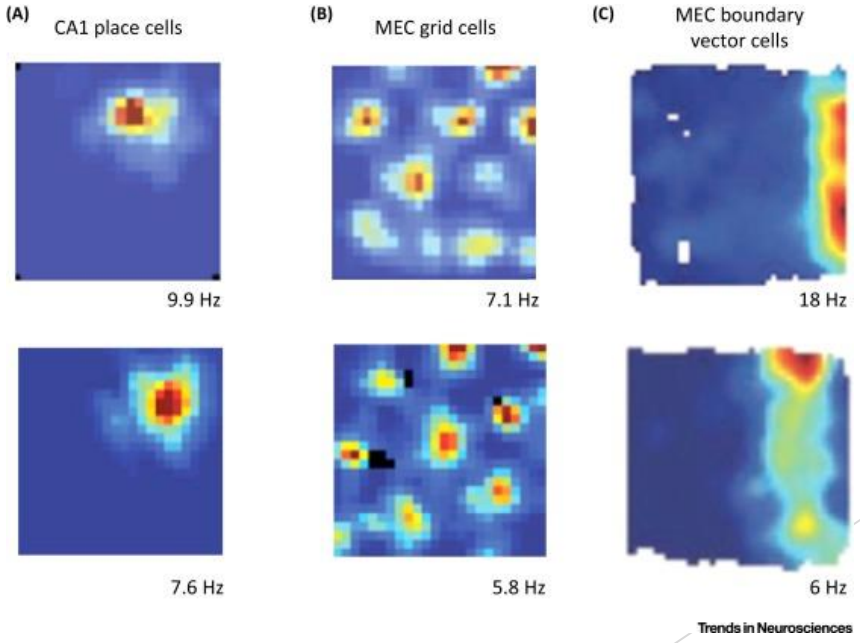


网格细胞
Grid Cell

- 在细胞层面上理解大脑如何映射环境的最重要的发现之一。

  One of the most important discoveries in understanding the cellular basis of how the brain maps spatial environments.

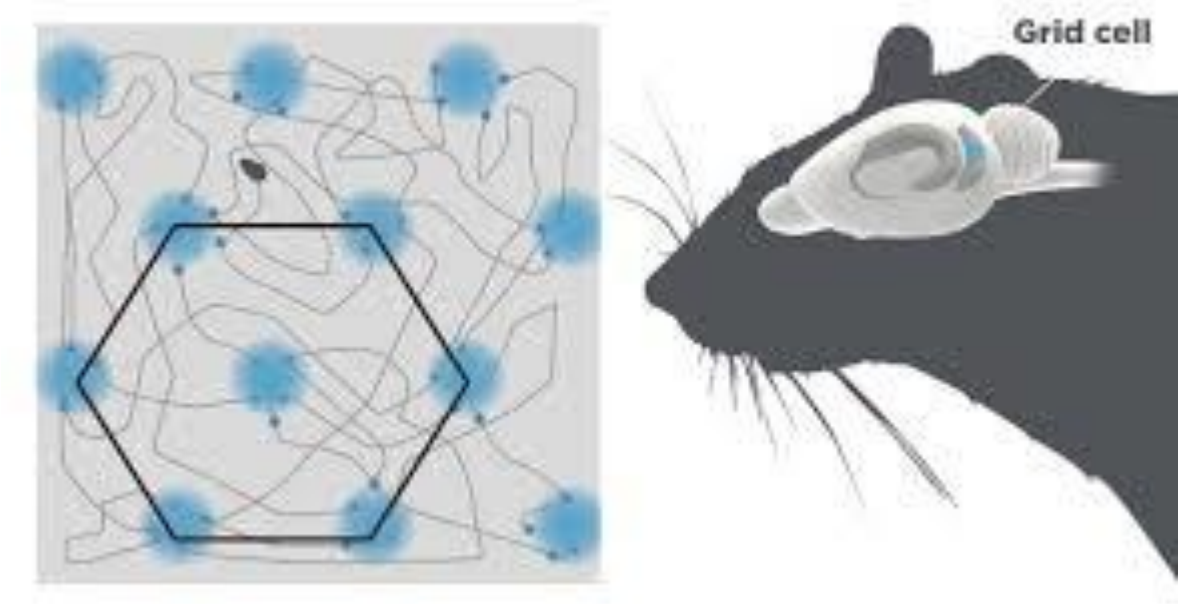




网格细胞
Grid Cell

- 群体层面的网格细胞的放电模式，可以覆盖整个环境空间。

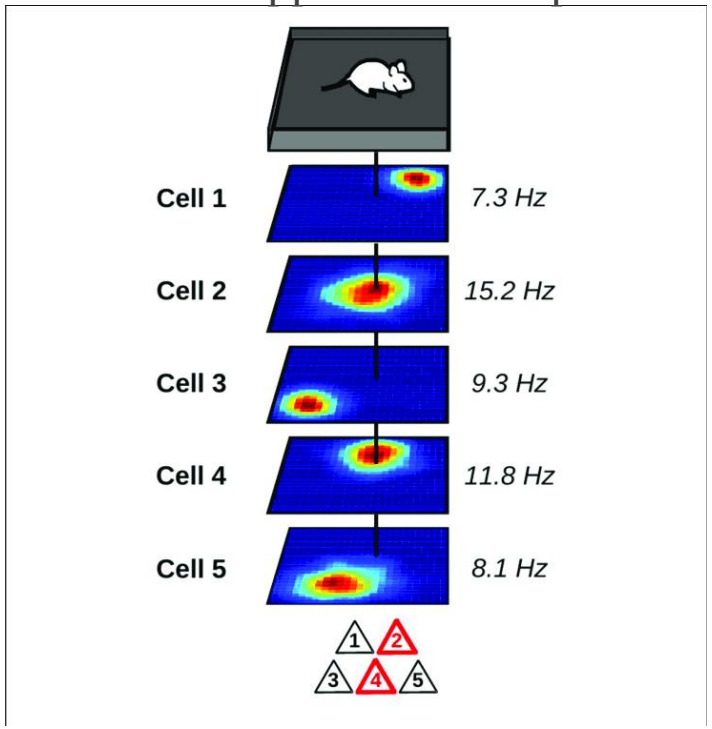
  The relative firing rate of grid cells at a population level is able to represent the entire spatial layout of an environment.



位置细胞
Place Cell

- 这类细胞只有当小鼠逼近特定位置时，才会激发。

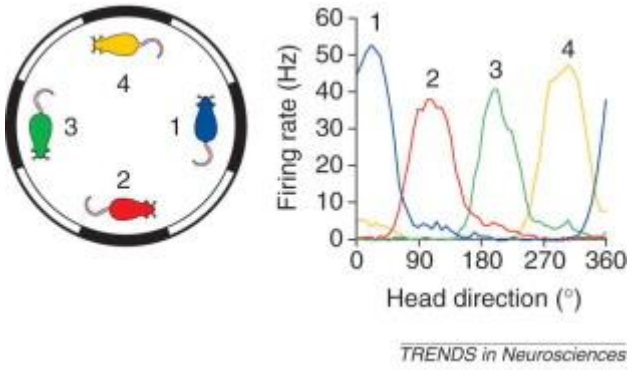
  These neurons display place fields – receptive fields within an environment – where there is an increase in firing rate as the rat approaches a specific location in the environment.

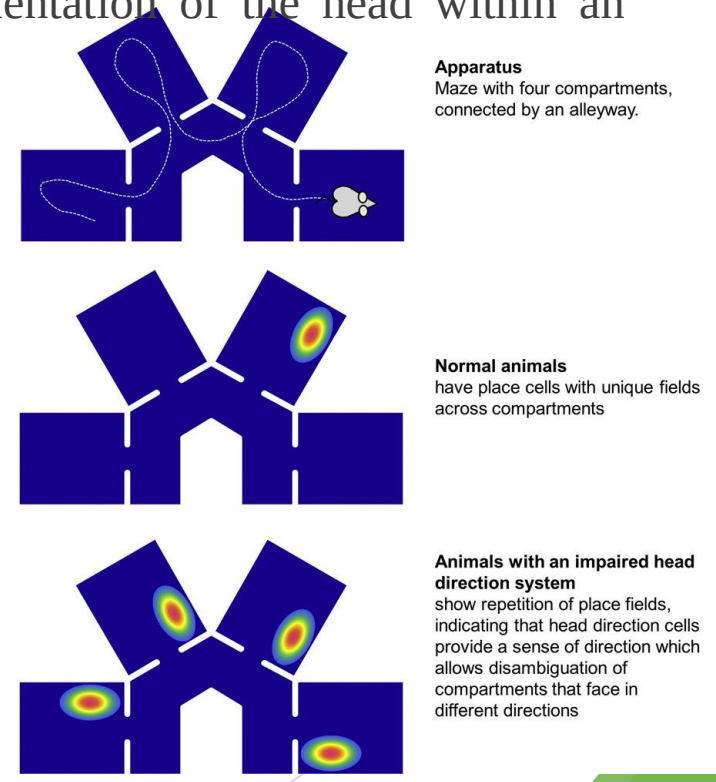


朝向细胞
Head Direction Cell

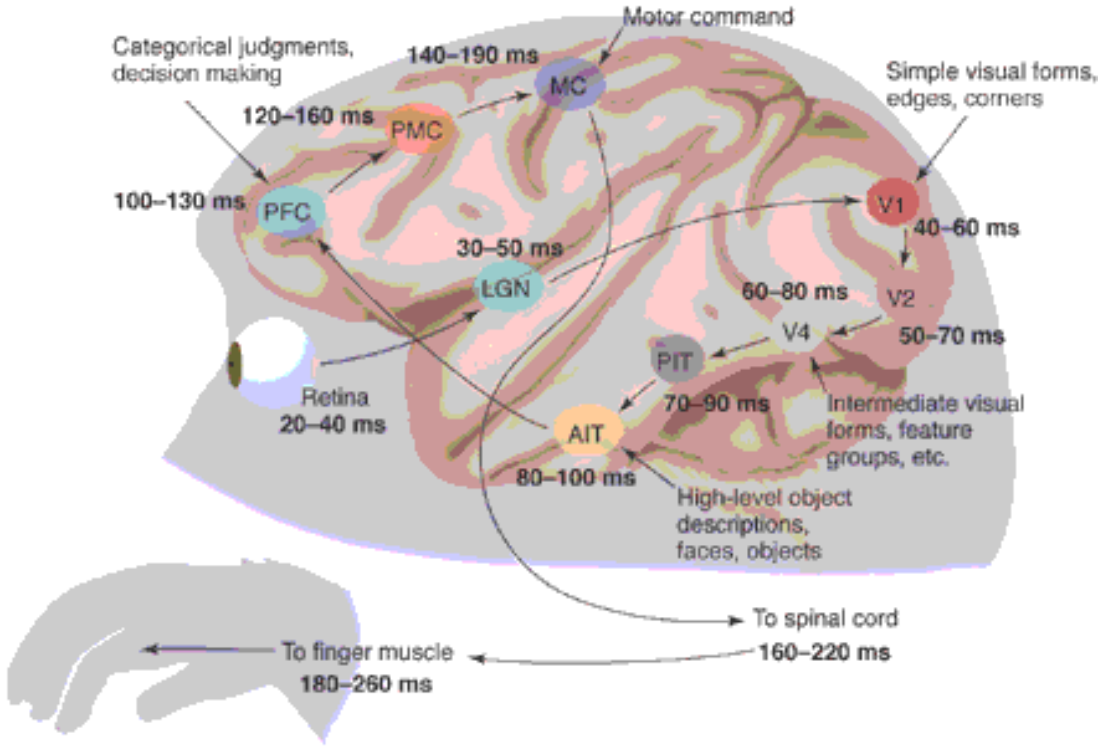
- 此类细胞只有当小鼠头部处于特定朝向时，才会激发。

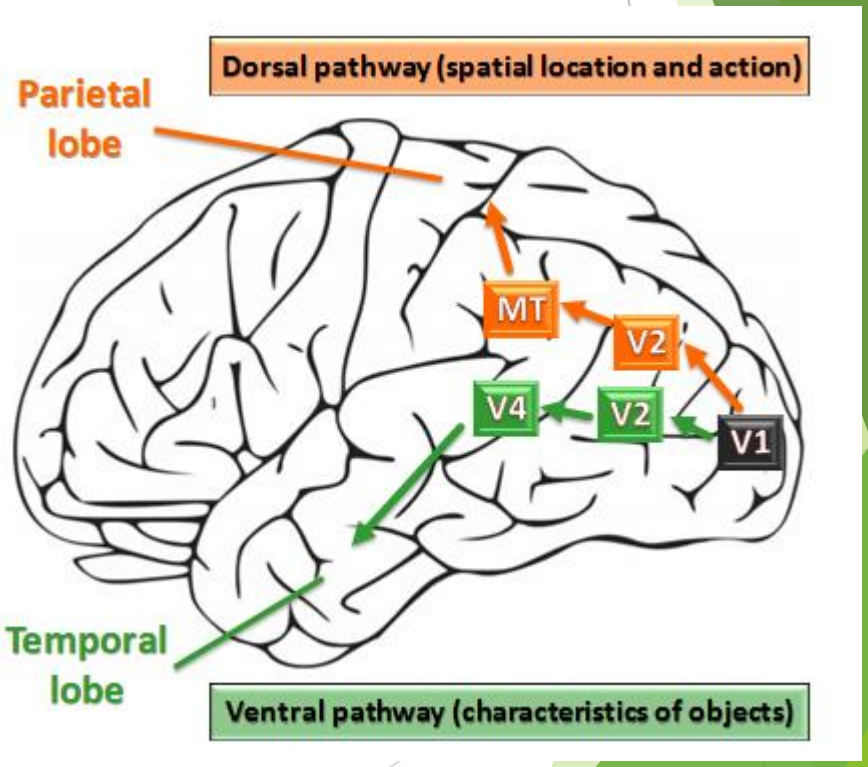
  These neurons fire over a rotational range of 90 with maximal firing occurring near the middle of the range and are contingent upon the orientation of the head within an environment.





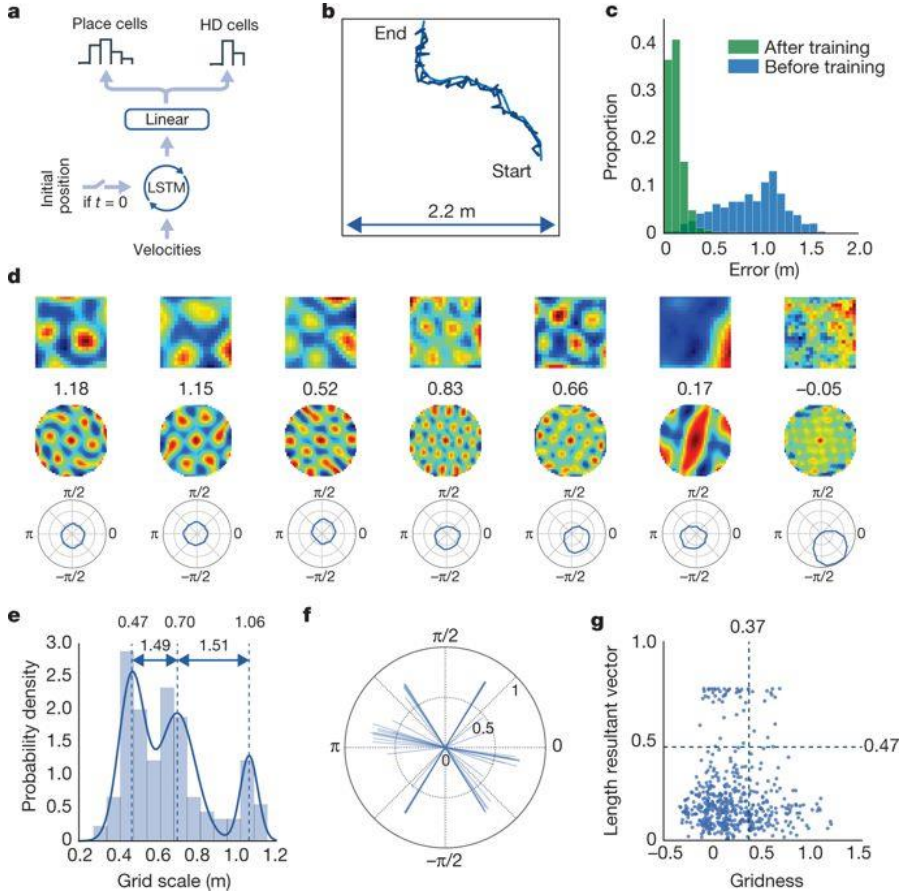
视觉系统
Visual System





人工智能体
Artificial Agents

- Vector-based navigation using grid-like representations in artificial agents



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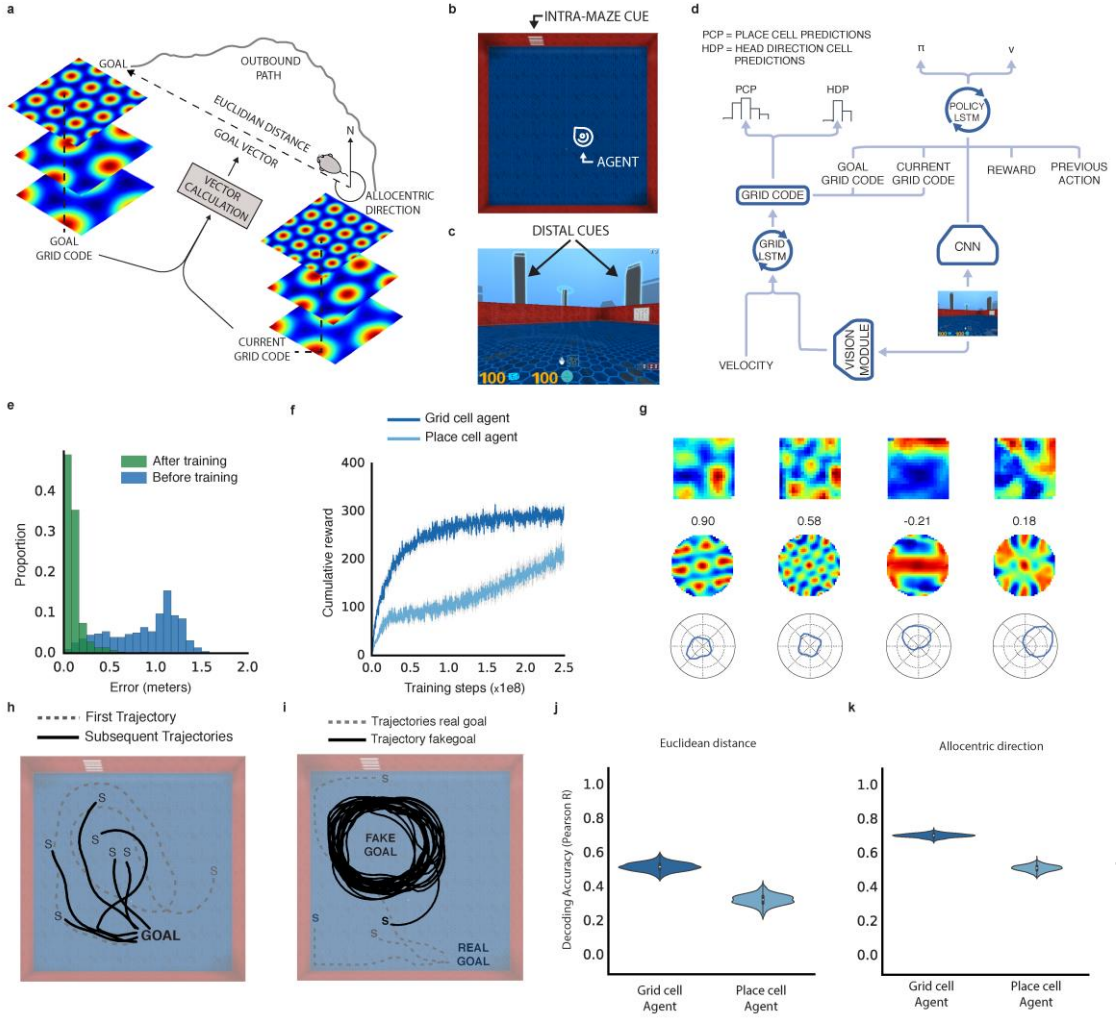

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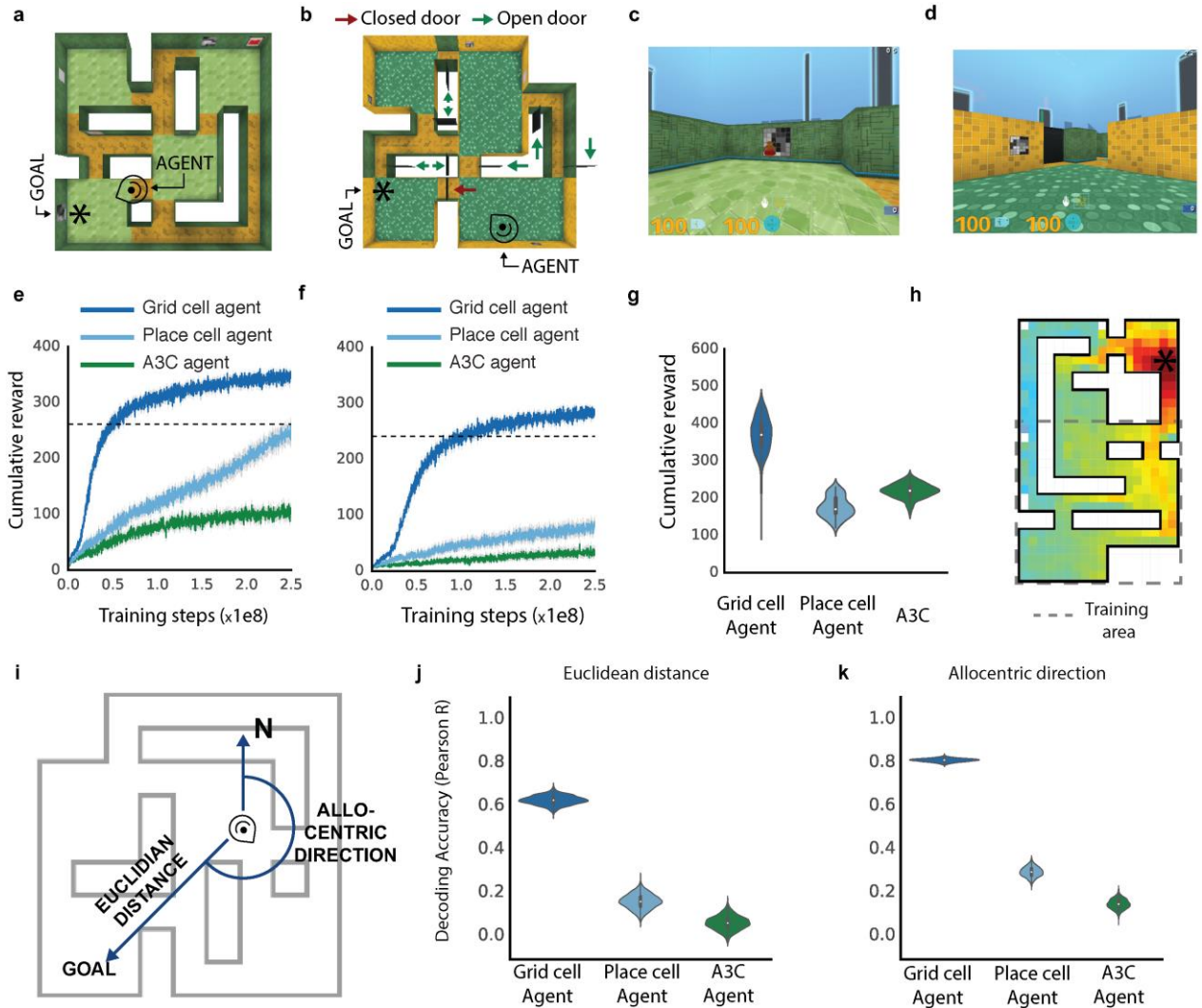

Computation Paradigm
计算模式

- 我们可以看到，单个神经元的行为模式或计算模式十分简单。大部分神经元，只是在主体处于特定位置或特定朝向时，激发一下。但正是这种激发模式，综合起来形成复杂的行为模式。

  It can be spotted that the behavior for a single neuron could be rather simple. Most of these neurons only activates when the subject is in specific position or orientation. However, by integrating all of these simple behaviors, the subjects can exert exceedingly complicated behavioral patterns.

- 无论从哪个层面，研究生物智能的本质及表观，都是非常重要的。由于智能这个范畴本身的复杂性，对生物智能的研究，或多或少都会在一定程度上启发机器智能的研究与设计。

  Either from the essence or appearance, the research into biological intelligence is of crucial importance. Because of the complexity of the concept with respect to intelligence, study on biological intelligence can surely to some extent benefit the investigation and design of machine intelligence.