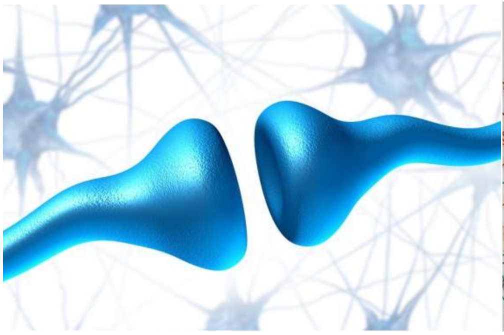
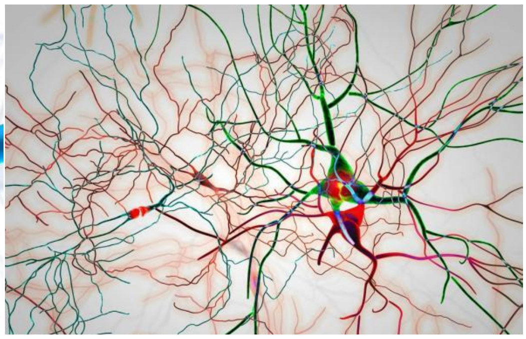
Silent synapses[1]

**文章导读：**突触是神经元之间信息传递和加工的关键结构，在脑和脊髓中，整个神经元表面积(包括胞体、树突和轴突)有60%~80%的部位被突触所占据。突触结构及功能方面的可变性称为突触可塑性，它与神经系统的发育、损伤后的修复以及学习记忆等重要脑功能的完成密切相关，长时程增强和长时程抑制是突触可塑性的两种主要表现形式，也是神经元网络可塑性的诱发者。目前，对突触可塑性的研究已成为各种干预措施治疗神经精神类疾病的共同靶点，是神经康复领域研究的热点和重点。





How adult brains learn the new without forgetting the old
成人大脑如何在不忘旧的情况下学习新知识

Learning new things is hard. Remembering what has already been learned is harder. Any successful learning system, be it a brain or a piece of artificial intelligence software, must strike the right balance between stability and flexibility. It must be stable enough to remember important old things yet flexible enough to learn new ones without destroying old memory traces—preferably for as long as it exists.
学习新东西很难。记住已经学到的东西更难。任何成功的学习系统，无论是大脑还是人工智能软件，都必须在稳定性和灵活性之间取得正确的平衡。它必须足够稳定，能够记住重要的旧事物，同时也必须足够灵活，能够在不破坏旧记忆痕迹的情况下学习新事物。

重点句型：Any successful learning system, be it a brain or a piece of artificial intelligence software, must strike the right balance between stability and flexibility.
中主语是 Any successful learning system，谓语为 strike ，其中 be it a brain or a piece of artificial intelligence software 作为插入语，而且其为 whether it is a brain or a piece of artificial intelligence software 的变形。

咱们可以来模仿这个句型来写一段:

Any successful approach to environmental governance, be it a legislative or governmental measure , should strike the right balance between economic costs and environmental protection.
任何成功的环境治理方法，无论是立法还是政府措施，都应该在经济成本和环境保护之间取

[1] Synapses /ˈsɪæpsɪz/ n.(神经元的)突触

得正确的平衡。

Learning is a result of changes in the pattern of neural connectivity in the brain. Each connection between nerve cells, called a synapse, is a tiny gap between the ends of branches ramifying[2] from such cells. Messages jump across these gaps in the form of molecules called neurotransmitters[3]. Current estimates suggest there are 600 trillion synapses in a human brain. How, then, to deal with the stability plasticity dilemma—particularly as brains age and, as it were, fill up? Research by Dimitra Vardalaki, Kwanghun Chung and Mark Harnett at the Massachusetts Institute of Technology, just published in Nature, suggests one way is to preserve into adulthood a type of memory-forming synapse found in children. These are called silent synapses.
学习是大脑中神经连接模式变化的结果。神经细胞之间的每个连接，称为突触，是分支末端之间的一个微小间隙分支； 从这样的细胞中分离。信息以称为神经递质的分子形式跨越这些间隙。目前的估计表明，人类大脑中有 600 万亿个突触。那么，如何应对稳定性-可塑性的困境，尤其是随着大脑老化和填充的情况？麻省理工学院的 Dimitra Vardalaki、Kwanghun Chung 和 Mark Harnett 刚刚发表在《自然》杂志上的研究表明，一种方法是将儿童体内的一种记忆形成突触保存到成年期。这些被称为沉默突触。

Silent synapses—which, as their name suggests, transmit no signal from one nerve cell to another—are often found on the ends of slender[4], immature protrusions[5] from nerve cells, called filopodia[6]. Until now, it had been thought that these disappeared as a brain matured. But Drs Vardalaki, Chung and Harnett have shown not only that they are present in adulthood, but also that they are common, at least in mice. Just over a quarter of the connections they sampled in adult mouse visual cortices were silent synapses on filopodia. And murine[7] and human brains are sufficiently alike that something similar almost certainly applies to people.
沉默突触，顾名思义，它不会从一个神经细胞向另一个神经元传递信号，通常位于神经细胞中细长的、未成熟的突起的末端，称为丝状体。直到现在，人们一直认为，随着大脑的成熟，这些东西会消失。但 Vardalaki、Chung 和 Harnett 博士已经表明，它们不仅存在于成年期，而且很常见，至少在小鼠中是如此。他们在成年小鼠视觉皮层中采集的连接中，有四分之一以上是丝状体上的沉默突触。而且老鼠和人类的大脑非常相似，几乎可以肯定，类似的东西也适用于人类。

To carry out their search for filopodia,the trio used a sensitive microscopy technique called eMAP. They studied 2,234 synapses between cortical nerve cells of a type called pyramidal neurons (pictured), which have thousands of synapses each. Peering through an eMAP microscope is enough to determine which cellular protrusions are filopodia. But it cannot show which synapses on them are silent.

2 Ramify /ˈræmɪfaɪ/ 分支；分枝；分歧
3 Neurotransmitters 递质；神经传导物质；神经介质；神經傳遞物質；神经传递物质
4 Slender /ˈslendər/ adj.苗条的；纤细的；微薄的；细的；窄的；不足的
5 Protrusions / prəˈtruːʒənz/ 突起；突出物；突起部
6 Filopodia 丝足
7 Murine 鼠类；鼠科

为了寻找丝状体，三人使用了一种叫做 eMAP 的灵敏显微镜技术。他们研究了 2234 个皮质神经细胞之间的突触，这种神经元被称为锥体神经元（如图所示），每个神经元有数千个突触。通过 eMAP 显微镜观察足以确定哪些细胞突起是丝状体。但它无法显示它们的哪些突触是沉默的。

To do that, they needed to test how the filopodia responded to glutamate[8], the brain's main excitatory[9] neurotransmitter. First, they had to deliver a controlled flow of glutamate to the particular synapse they wanted to test. To this end, they poured a soup of "caged" glutamate over the neuron under examination. This form of the molecule is inert until hit with energy from the intersection of two laser beams.
为了做到这一点，他们需要测试丝状体对谷氨酸（谷氨酸）的反应，谷氨酸是大脑的主要兴奋性神经递质。首先，他们必须向他们想要测试的特定突触输送受控的谷氨酸。为此，他们在接受检查的神经元上浇了一碗"笼中"谷氨酸。这种形式的分子是惰性的，直到被两个激光束相交的能量击中。

Aiming those at the synapse under study enabled them to uncage the neurotransmitter and see, by measuring the electrical activity in that part of the neuron using an ultrafine electrode, whether the synapse responded. They found that mature pyramidal-neuron protrusions generated electrical activity when exposed to glutamate, as expected. Filopodia did not,confirming the silence of their synapses.
将研究对象对准突触，使他们能够解开神经递质，并通过使用超细电极测量神经元这一部分的电活动，观察突触是否有反应。他们发现，正如预期的那样，成熟的锥体神经元突起在接触谷氨酸时会产生电活动。丝状体没有，证实了它们突触的沉默。

Silent synapses are, however, useless unless they can be switched on at the appropriate moment. And the researchers confirmed this is possible. They were able to induce the silent versions on filopodia to turn into mature, active synapses by pairing the simulated release of glutamate with a subsequent surge of electricity inside the neuron.然而，沉默的突触是无用的，除非它们能在适当的时候被打开。研究人员证实这是可能的。他们能够通过将模拟的谷氨酸释放与神经元内部随后的电流激增相结合，诱导丝状体上的沉默版本转变为成熟、活跃的突触。

This pairing of events caused silent synapses to start, within minutes, displaying receptor molecules characteristic of active synapses. The same pairing, applied to mature synapses, did nothing. The researchers thereby show it is hard to get a mature synapse to change the strength of its connection (thus satisfying the stability side of the dilemma), but easy to unsilence a silent one (satisfying the plasticity side).
这对事件导致沉默的突触在几分钟内启动，显示出活跃突触的受体分子特征。同样的配对应用于成熟的突触，却没有起到任何作用。因此，研究人员表明，很难得到一个成熟的突触来改变其连接的强度（从而满足困境的稳定性方面），但很容易让一个沉默的突触（满足可塑性方面）停止。

[8] Glutamate /ˈɡluːtəmeɪt/ 谷氨酸；谷氨酸盐（酯、根）
[9] excitatory 有刺激性的，兴奋的

The next thing to investigate is how, why and when new filopodia appear. The discovery of all these eager-to-learn silent synapses and filopodia, Dr Harnett says, “is a lever for us to get into understanding learning in adults and how potentially we can get access to make it not degrade over the course of ageing or disease”.

下一件要调查的事情是如何、为什么以及何时出现新的丝足类。哈奈特博士说，所有这些渴望学习的沉默突触和丝状体的发现，“是我们了解成人学习的一个杠杆，以及我们如何获得机会使其在衰老或疾病过程中不退化”。