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科學美國人

How GPS Weakens Memory—and What We Can Do about It

GPS 如何讓記憶力衰退 — 以及我們該怎麼防範

Using mobile phones to navigate has become second nature. Whether you're heading to a new park, meeting friends at a restaurant, or going to run errands, you just tap the location on your phone and go. Prior to GPS, exploring and wayfinding in new places required preparation. We had to think, consult paper maps, and plan and memorize parts of our route. But in today's technological world, there is no need to think. Simply follow the turn-by-turn directions on your phone, and you'll end up where you need to be. But your overall sense of the place suffers. Spatial navigation, which had been a process performed exclusively by the human brain and perceptual system, has now been surrendered to technology.

使用手機導航已成為我們的第二天性。無論你是前往從未去過的公園、與朋友聚餐、或是出差，只消在手機輸入地址就可以出發了。在 GPS 問世以前，探索和找尋新的地點需要事先準備。我們必須訴思考、查閱紙本地圖、計畫、並記憶部分的路線。但在科技發達的今日，已經沒必要思考路線了。只要一步步的照著手機的指示，你便能順利的抵達目的地。但這也讓你不會特別留意這個地方的任何特色。空間導航，這原本全部由人腦和感官系統所掌控的功能，現已被科技取代。

However, in doing so, we also surrendered our agency. Does it matter?

然而，全由科技代勞等於放棄我們獨立執行的能力。這有什麼問題嗎？

There are structures in the brain dedicated to these complex pathfinding tasks. In particular, the hippocampus is deeply associated with supporting spatial memory, spatial navigation and mental mapping.

人腦中有構造專門處理複雜的探路工作。其中，海馬迴與空間記憶、空間導航和腦海中構建認知地圖等功能高度相關。

Anthropologists have gone so far as to suggest that navigation needs might have been the starting point for all memories (as discussed in Nicholas Carr's book *The Glass Cage*). For example, mnemonic techniques for remembering large numbers such as the digits of pi often rely on the "memory palace" (or "method of loci") made famous by Cicero, with multiple floors and connected chambers in which one mentally stores the digits. One can then recall a long sequence of digits through an imaginary navigation, revisiting the chambers of this memory palace.

人類學家甚至表明，人類的所有種類的記憶可能是源自導航的需要，(正如美國作家尼古拉斯．卡爾所著的 《The Glass Cage》〔暫無中譯〕討論的那樣)。
例如，人們利用一種稱為「記憶宮殿」的技巧(又名 「位置記憶法」)背誦圓周率小數點後一連串龐大的數列。此記憶法因古羅馬政治家西塞羅而廣為人知。竅門是想像許多樓層和相連的房間，每個空間各自儲放一個數字；人們想像自己穿梭在這座記憶宮殿的房間，藉此記住一長串數字。

IF WE DON'T USE IT, WE LOSE IT
能力不使用便會荒廢

As we age, our memory declines. And while there is no silver bullet for healthy aging, neuroscientists agree that one of the key ingredients of successful aging is staying mentally active. Studies show that we can actually exercise the hippocampus memory through exploration and spatial navigation. Expert navigators such as London cab drivers have larger hippocampi compared to regular populations in consequence of their intensive spatial mapping and multisensory experience of the city.
記憶力隨著年齡增長衰退。
即便沒有萬靈丹，神經科學家同意健康老去的關鍵是保持精神活躍。
研究指出自行探索路線和空間導航有助於鍛鍊海馬迴。
與普通人相比，專家級的導航人員，比如倫敦的計程車司機，有更大的海馬槽。
這是因為他們比一般人更密集的使用空間映射並以多重的感官感受周遭的城市。

If spatial navigation is such an essential element to healthy aging and mental activity, why surrender this critical skill to our phones? By following a set of digital turn-by-turn directions, GPS navigation apps treat us as passive passengers rather than active explorers, removing our agency to make decisions. In turn this inhibits our ability to create proper mental maps of the surrounding environment, and negatively impacts the hippocampus, which is critical for brain health.
如果空間導航對於健康老去如此重要，我們又為什麼要將這麼關鍵的
技能交給我們的手機呢？
當我們一步一步遵從 GPS 的指示時，我們只是被動的旅客，不是自發的探索者，而這剝奪了我們做決定的能力。
更糟糕的是，這抑制了我們在腦海中根據周遭環境描繪地圖的能力。我們的海馬迴 —— 對腦部健康非常重要的器官，因此遭受了負面的影響。

While advances in technology clearly have many benefits, we must remain mindful that technology can influence the brain. Ultimately our goal should be to create and design technology in ways that complement our brain and enhance our opportunities to interact and engage with the real world around us.
科技的演進確實帶來許多好處，但我們仍必須警惕科技對大腦帶來的影響。
科技的目的終究是輔助我們的大腦並增加我們與現實世界互動的機會。

PHYSICAL MAPS, THE FIRST REVOLUTION
實體的地圖，第一次革命

Mental maps arise from direct experience. As we explore new environments, the brain constantly maps out our surroundings. And we use all of our senses to learn about and remember our surroundings, not just vision. In particular, evolution rewarded auditory navigation: as hunter-gatherers we listened to the environment and moved towards sounds, allowing us to avoid predators, track prey and locate water sources. Our brains ultimately could generate detailed maps of our environment through active exploration, a hard-won evolutionary skill that never went away.
認知地圖來自於第一手的體驗。
當我們探索新的環境時，大腦正持續的在腦中描繪周遭的景象。
我們會運用上所有的感官— 不只是視覺，去學習與記憶周圍環境。
在所有感官中，使用聽覺導航在演化中特別有利：人類曾以狩獵採集維生。我們的祖先傾聽大自然的聲音，以避開掠食者、捕捉獵物，並發現水源。
我們的大腦會在探索的過程中自發的產出詳盡的地圖：這個經過長年演化，得來不易的技能從未消失。

So even today, strolling along a modern city waterfront, we might hear the petulant squawks of seagulls fighting over a bread crust, or the low throaty notes of approaching ships in the fog. We refer to such distinctive, spatially situated sounds as *auditory beacons*.
時至今日，當我們漫步在城郊外的海濱時，或許能聽見海鷗爭奪麵包屑的喧鬧，或是霧中駛近船隻的低鳴。我們將這種獨特的、與空間息息相關的聲音稱為「聽覺信標」。

However, as civilizations expanded and grew, it became more difficult to navigate over long distances only through sensory experiences and memory. One cannot sail to another continent on senses alone. So, maps were a revolution for humanity. Rudimentary maps were created as early as 16,500 B.C. when people drew paintings on the walls of caves showing stars or landscape features. Later, these were carved into wood or rocks so they could be carried while traveling. But it wasn't until the ancient Greeks and early Chinese dynasties that the first paper maps appeared.
然而，當文明不斷地發展演進，光靠感官和經驗已不足以導航遙遠的路途。
人無法單憑感官航行到另一個大陸。
也因此，地圖曾經人類是劃時代的發明。
最原始的地圖約在西元前16500年發明。當時的人在洞穴的牆上畫上星星或地表特徵。
後來改為刻在木頭或岩石上，方便旅行時攜帶。
但一直等到古希臘時代和中國古代才出現紙本的地圖。

Physical maps were a revolution. They can contain enormous amounts of information about the surrounding environment on a simple piece of paper, but using them successfully requires both the correct placement of oneself within the map and the correct heading. Maps are an example of *allocentric* navigation, with *allo-* meaning "other": all the information on the map is displayed as it relates to other features and landmarks within the environment.
實體的地圖堪稱革命。
地理空間資料。但要有效地使用地圖需要兩項關鍵的技能：正確的定位和辨別方位。

地圖是環境導航(allocentric navigation)的一個範例，英文的 「allo」意指「其他」，圖上的地標和訊息都與其周遭的環境互相關聯。

In contrast, a set of directions is direct and easy to follow. Directions are an example of egocentric navigation, with *ego-* meaning "self": all information is relative to the person's current position and orientation. However, egocentric navigation and directions are considerably less flexible as they only work from a single location and contain significantly less information about the broader environment.
與之相反的，遵守一連串方向的指示非常的直接容易。
方向的指示採用自我空間巡行(egocentric navigation)，英文「ego」意指「自我」：自我空間巡行，所有的訊息只和人當下的位置和接下來前往的方位有關。
但是，自我空間巡行提供的訊息遠不如環境導航豐富，也遠不及環境導航來的有彈性。因為自我空間一次只考慮一個位置，而不是空間的整體。

The challenge is that physical maps can be very abstract and require many other techniques to operate, such as the ability to determine where in the map one is located. Indeed, maps evolved in parallel with wayfinding techniques. Wayfinding tools empower self-location, from compass to stars, latitude, longitude and realigning landmarks. Such tools allow us to achieve the self-location and heading necessary for allocentric navigation. But the expertise needed to be a successful navigator is not within everyone's grasp. Even commercial airplanes used to have an expert navigator on board: a person dedicated to determining the aircraft's current position—and next changes to heading—on top of a map. At the individual level most of us didn't have the luxury to afford a navigator, and families would have table discussions preparing routes for their trips. And then assign their own familial navigators.
實體地圖的困難處在於它可能非常抽象，除此之外可能需要許多技巧，比如判別使用者正位於地圖上的哪一個位置。
確實，實體地圖的發展與領航技術的演進同時並行。
探路的工具如指南針、觀星、經緯度和重新調整地標幫助人們更有效的定位。
這些工具幫助人們有效的自我定位並強化了環境導航。
但不是每個人都能成為稱職領航員。
即使是商用飛機，都曾需要專業的領航員在機上負責確認飛機當前的位置和接下來的方位，單憑地圖不足以成事。
大多數人無法聘請領航員，所以在全家出門旅行前，大家會在桌子上一起討論旅途的路線該怎麼走。然後指派一個人在旅途中引導方向。

GPS NAVIGATION
GPS 導航

The rise of satellite-enabled GPS was revolutionary for navigation, and with the rise of mobile phones, anyone can have their personal navigator. We can go places spontaneously, with little need for planning or additional people to navigate. GPS navigation apps enable egocentric navigation with easy-to-follow turn-by-turn directions: "Turn right in 100 meters, then turn left," all the way to the destination. With these conveniences at our fingertips, we are no longer active navigators; we are passive passengers aboard the GPS.

衛星 GPS 的興起為導航帶來了革命性的變化。再加上智慧手機的普及，任何人都可擁有自己的導航系統。
我們可以隨興所至的前往任何地點，不再需要事先的計畫和任何人的幫助。
GPS 導航 APP 採用自我空間巡行，使用方式極其簡單：“向右 100 公尺，然後左轉”，一直到你抵達目的地為止。
這些便利的功能觸手可及，但這也讓我們被動的被 GPS 左右，不再是積極的領航者。

However, multiple experiments have shown that this easy egocentric navigation also reduces spatial awareness and mental mapping when compared to more traditional forms of allocentric navigation like paper maps. See for example recent work by Eran Ben-Elia comparing paper maps to Google Maps, in which app users significantly underperformed on traditional memory map tasks such as pointing or landmark recognition.
況且，多項實驗證明簡單的自我空間巡行，不同於紙本地圖(採用傳統的環境導航)，降低了使用者對空間的感知和建立認知地圖的能力。
根據以色列大學地理與環境發展系的研究人員 Eran Ben-Elia 最近的研究，對照導航 APP 和傳統地圖的使用者，前者在與記憶地圖有關的活動：例如指向或地標識別等，表現明顯較差。

Our question is: Can we find a way to still use GPS but reduce the harmful effects of current GPS navigation on memory?
我們想問的是：有沒有什麼辦法能讓我們一邊享有 GPS的便利 ，同時避免我們的記憶力受到損害呢？

The challenge is to create alternative forms of GPS navigation that will remain easy enough for the general public, but also enable allocentric navigation and thus be more likely to improve spatial awareness.
開發替代現有的 GPS 系統的困難處在於：要讓功能足夠簡單，讓普羅大眾都能輕易上手，同時又必須採用環境導航的方式，加強使用者對空間的感知。

Our research finds that appropriately designed audio beacons offer an alternative that fosters a much more active form of egocentric navigation. Instead of guiding users to turn right and turn left on the way to their desired destination, we can convert a location of interest to a distinctive auditory beacon (digital versions of the aforementioned petulant squawks and low throaty notes) via earbuds or headphones. Our auditory navigation application, known as Soundscape, has an effect that resembles a church bell or minaret, where peals or calls to prayer can be heard at great distance; our would-be navigator can make way by heading toward the sound.
我們的研究發現，適當設計的聽覺信標提供了一種替代方案，比起自我空間巡行，此方法讓使用者扮演更主動的角色。與其讓使用者單純聽從指示左轉右轉直到終點，我們將使用者欲前往的地點轉化成讓使用者聯想到該地點的聽覺信標(還記得前面提到的海鷗叫聲和船鳴嗎？只不過是以數位呈現)，使用者只要戴上耳塞或耳機便能接收到信標的訊息。
我們的聽覺導航應用，名為 “Soundscape”(聲景)，效果類似教堂的大鐘或伊斯蘭宣禮塔，宏亮的鐘聲和禱告即便在遠處也能聽到，引導我們的使用者隨著聲音前往目的地。

But audio beacons can be created for any chosen destination, and without sound decay, so they can be heard from as far away as needed. With an audio beacon at the destination, a pharmacy two miles away can produce a sound that we can hear through our phone. Then one simply moves towards it, but unlike with turn-by-turn directions, you can build spatial awareness through active and direct exploration of the environment along the way.
任何地點，不論路途遠近，聽覺信標都能發揮作用，因為數位不像物理的聲音會隨距離減弱。只要在目的地設置聽覺信標，即便是兩英里外的藥局發出的聲響，我們都能透過手機聽到。任何人只要跟隨聲音的方向前進，但與單純的聽從左右轉的指示不同的是，你在旅途中積極直接的探索環境的同時，你也對該環境有更深刻的感覺和知識。

In recent experiments, available in our publication in *Scientific Reports* (an open-access journal by the publisher of *Nature*), we show that this type of sensory navigation through audio beacons outperforms turn-by-turn navigation in the creation of mental maps.
近期的研究 (可參閱《科學報告》，這是《自然》開放給公眾的期刊)，我們展示了這種透過聽覺引導的聽覺信標，比起一口令一動作的導航有助於使用者創造出認知地圖。

We believe these results, at least in part, derive from people taking a more active role in their navigation. They explore more while using auditory beacons, and can engage with the environment, both of which support allocentric navigation and the construction of mental maps.
我們相信這結果，至少在一定程度上，讓人們得以在導航中扮演更積極的角色。
使用聽覺信標時，人們能更進一步的探索，並與環境有更深的互動，這有助於環境導航和建立認知地圖。

We invite the reader to try such auditory beacon experience by trying the Soundscape app on their mobile phone. The Soundscape team originally designed the app as an experimental tool to enable blind and low vision populations with a potentially safer, more robust and accessible navigation than turn-by-turn options; to date, it has enabled over 500,000 walks in seven countries.
我們邀請閱讀這篇文章的讀者在手機上試用類似聲景這種運用聽覺信標技術的 APP。
聲景的開發團隊一開始的初衷是作為實驗工具，提供盲人和弱視人群比逐行選項更安全、可靠、更容易理解的導航方式。
至今，聲景已在七個國家，導航了超過 500,000 次的路途。

Auditory beacon navigation is an example of how we are entering into an era where noxious effects of automation on our brain health will be at the forefront of technological development. Technology does not need to replace our evolutionary functions and distance us from our environments, but rather with appropriate design can complement the sensory inputs processed by our brain. In that regard, GPS navigation based on auditory beacons offers a compelling example of a sensory augmentation that helps humans connect more deeply with reality; perhaps instead of evolving into a new species of turn-by-turn zombies, we can thereby all engage more deeply with humanity, our local environment, and life itself.
聽覺信標導航的發明象徵我們正進入一個時代。在這個時代，自動化在科技的發展佔據重要地位，但對人腦有不良影響。科技不一定要取代人類經過長年演化得來的功能，並使我們與

生活的環境脫節。若是設計得當，科技可幫助大腦處理感官的輸入。在這方面，採用聽覺信標技術的 GPS 導航強化了感知系統，讓人類與現實更加的緊密相連，這便是科技協助人類，而不是取代人類演化功能的一顯著例子。

或許我們不但不會漸漸變成唯科技是從的殭屍，反倒能更深刻體會的與其他人類、與周遭的環境，甚至與生命本身的關係。