NEUROSCIENCE

A Pokémon-sized window into the human brain

Every person develops brain regions to recognize people, places and things; these regions end up in similar locations across brains. However, people who played Pokémon extensively as children also have a region that responds more to Pokémon than anything else, and its location is likely determined by the size of the Pokémon on the video game player's screen.

Daniel Janini and Talia Konkle

Everything we learn to recognize changes our brain in some way. With functional neuroimaging, we can now measure how the human brain has learned to organize all the things we see. For example, some regions of the visual brain respond most to faces while others respond most to scenes, but not all object categories can claim their own dedicated region (for example, there are no shoe or car regions). Interestingly, these regions are spatially organized in pretty much the same way from brain to brain. These facts raise a number of deep questions: why do some things have localized brain regions while others don't, and why are these regions where they are? A recent study by Gomez, Barnett and Grill-Spector in *Nature Human Behavior*[1] used an exceptionally clever approach to gain insight into these questions by measuring the brains of Pokémon experts.

The Pokémon experts who participated in the study had all played the handheld video game heavily throughout their childhood, beginning between ages 5 and 8. Gomez et al. show that this extensive early visual experience led to large-scale changes in their adult brain responses. A region in the occipitotemporal sulcus responded more to pictures of Pokémon than to other depicted objects. In contrast, no Pokémon region was found in another group of nonexperts.

These results alone are worth dwelling on for a moment. Certainly, playing Pokémon for years of one's life must change the brain at some level of structure. However, what is remarkable is that these changes happened at such a large scale: centimetres of cortex encompassing millions of neurons now have different functional properties as a result of this intensive Pokémon playing.

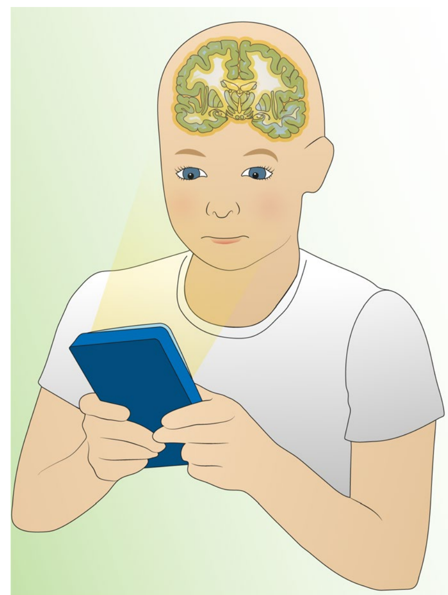
We knew that this kind of experience-based regional formation was possible, as children learning to read develop a nearby region that responds most to words[2]. In fact, young monkeys taught to distinguish letters also develop letter-selective regions in their brain, regions that do not develop in adult monkeys who are given the same training[3]. Along with these previous studies, the current finding of a Pokémon-preferring brain region really drives home just how amazing the plasticity of our developing visual system is.

Critically, this Pokémon-preferring cortex also provided the authors with a unique opportunity to consider different hypotheses about what properties determine the large-scale organization of visual cortex as it develops. The authors argue that the viewing small Pokémon with central vision is the only factor that predicts the location of Pokémon-preferring cortex, rather than other prominent alternatives related more closely to what the Pokémon look like (for example, their curvature, shape, size and animacy).

So, here is a two-step origin story for why Pokémon-preferring cortex and the other visual brain regions are where they are.

First, the things we see may be intrinsically tied to an underlying eccentricity bias. For example, playing Pokémon on a tiny screen means that those Pokémon characters only take up a very small part of the centre of our view. Faces usually take up an intermediate portion of the visual field, while scenes fill our view and extend all the way into the periphery. In general, differently-sized objects likely have different experienced eccentricities, based on physical constraints of how we interact with them in the world[4].

Second, these eccentricity biases may determine where category-preferring regions develop[5,6]. From the very earliest stages of visual processing, some regions process information at the centre of gaze, and others the periphery, and these biases extend into the cortex that comes to represent object categories. Gomez et al. show that the Pokémon-preferring region developed in cortex that has a centre-of-gaze preference, next to a face-selective region, while a scene-selective region developed in cortex with a far-periphery preference.



Credit: Bethany Vuckomanic / Nature Publishing Group

However, as the authors themselves note, this is indirect evidence for an eccentricity-bias account. A more direct test of the hypothesis would require raising two populations of kids with two different object categories seen at two different visual sizes—a study that would quite reasonably raise some flags with internal review boards.

Additionally, recent work adds to the complexity of the picture, suggesting that an eccentricity bias alone might not be the entire story. Monkeys who get intensive early experience with three different shape categories go on to develop three distinct and consistently arranged patches for these categories, even though all categories were experienced with the same eccentricity biases[7]. Thus the shapes of things may also guide where regions develop in visual cortex.

So why does visual cortex come to have such a consistent organization? The study by Gomez et al. provides new inroads to this question by harnessing the natural experiment created by the Pokémon craze of the 1990s. This study exemplifies how powerful early visual experience is in modifying the organization of our visual system, and it affirms that this large-scale plasticity must follow systematic underlying rules. An underlying organization of visual cortex by eccentricity likely plays a role. Exactly how the brain learns to represent different shapes within this larger eccentricity organization is an exciting question that gets at the heart of what it means to learn to see. ❐

Daniel Janini and Talia Konkle*
Department of Psychology and Center for Brain Science, Harvard University, Cambridge, MA, USA.
**e-mail: talia_konkle@harvard.edu*

Published online: 6 May 2019
https://doi.org/10.1038/s41562-019-0594-6

References

1. Gomez, J., Barnett, M. & Grill-Spector, K. *Nat. Hum. Behav.* https://doi.org/10.1038/s41562-019-0592-8 (2019).
2. Dehaene-Lambertz, G., Monzalvo, K. & Dehaene, S. *PLoS Biol.* **16**, e2004103 (2018).
3. Srihasam, K., Mandeville, J. B., Morocz, I. A., Sullivan, K. J. & Livingstone, M. S. *Neuron* **73**, 608–619 (2012).
4. Konkle, T. & Oliva, A. *Neuron* **74**, 1114–1124 (2012).
5. Hasson, U., Levy, I., Behrmann, M., Hendler, T. & Malach, R. *Neuron* **34**, 479–490 (2002).
6. Malach, R., Levy, I. & Hasson, U. *Trends Cogn. Sci.* **6**, 176–184 (2002).
7. Srihasam, K., Vincent, J. L. & Livingstone, M. S. *Nat. Neurosci.* **17**, 1776–1783 (2014).

Competing interests

The authors declare no competing interests.