Your Mind's Eye: Metaphor or Reality?

An Exploration of the Varieties of Visual Imagery

By Alia Korot

If you are told to close your eyes and picture an apple, what do you see? Do you actually see an apple? What color is it? How detailed is it? Can you taste it? Smell it? Hear the crunch when you take a bite? Most people can easily answer these questions, and being told to picture something in their mind's eye makes perfect sense. However, if you're like me, you don't see anything when asked these questions. I know what an apple looks, tastes, and smells like, but I do not relive any of those sensations when told to picture something. For me, the mind's eye has always been a metaphor, and I only recently realized that my experience differs from the majority of people.

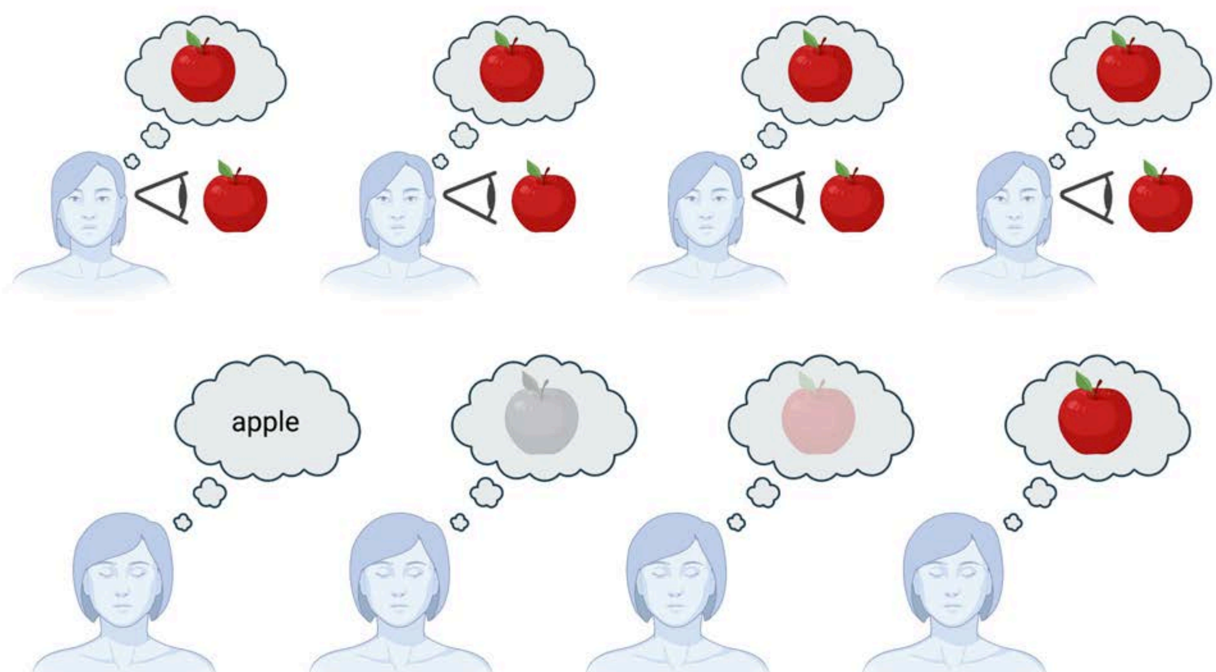
Like myself, many people are not even aware of their lack of imagery, or that it is abnormal until well into young adulthood. We rarely describe the details of our mental experience to others, and instead assume that others think and imagine in the same way we do. With phrases like "picture this" and "your mind's eye" so widespread in our everyday language, it is assumed that we all interpret their meaning in the same way. However, this is not the case, and recognizing this can help us try to understand the variety of ways that people think, imagine, and experience the world around them.

Early Studies of Aphantasia

The first recorded study of variations in visual imagery was conducted by Sir Francis Galton, a notable 19th century scientist, in 1880, who recognized that some individuals seemed to lack the power to visualize. However, this phenomenon has been mostly ignored since then, and the term to describe it was only coined in 2015 (1). This distinct experience has now been labeled aphantasia, which is defined as the absence of voluntary mental imagery. Based on what we know so far, aphantasia seems to be found in about 1-4% of people, but this number will likely change as awareness of the phenomenon grows (2).

The study that first defined aphantasia was conducted by a researcher named Rebecca Keogh and her colleagues (2). They used a survey called the Vividness of Visual Imagery Questionnaire (VVIQ), which describes a variety of situations and asks how clearly you can visualize them on a scale from seeing nothing to seeing something as detailed as real vision (this survey is available to the public online). The researchers gave this survey to a group of people who had self-reported a lifelong lack of visual imagery. Interestingly, around half the participants reported a dearth of all types of imagery,, but the majority still reported experiencing involuntary imagery, such as "flashes" while awake and dreaming (1). Personally, I don't experience any type of sensory imagery in my mind, whether that be visual, auditory, or olfactory. While I believe I do dream visually, I rarely (if ever) remember those dreams.

While this study provided the first cohesive report of aphan-

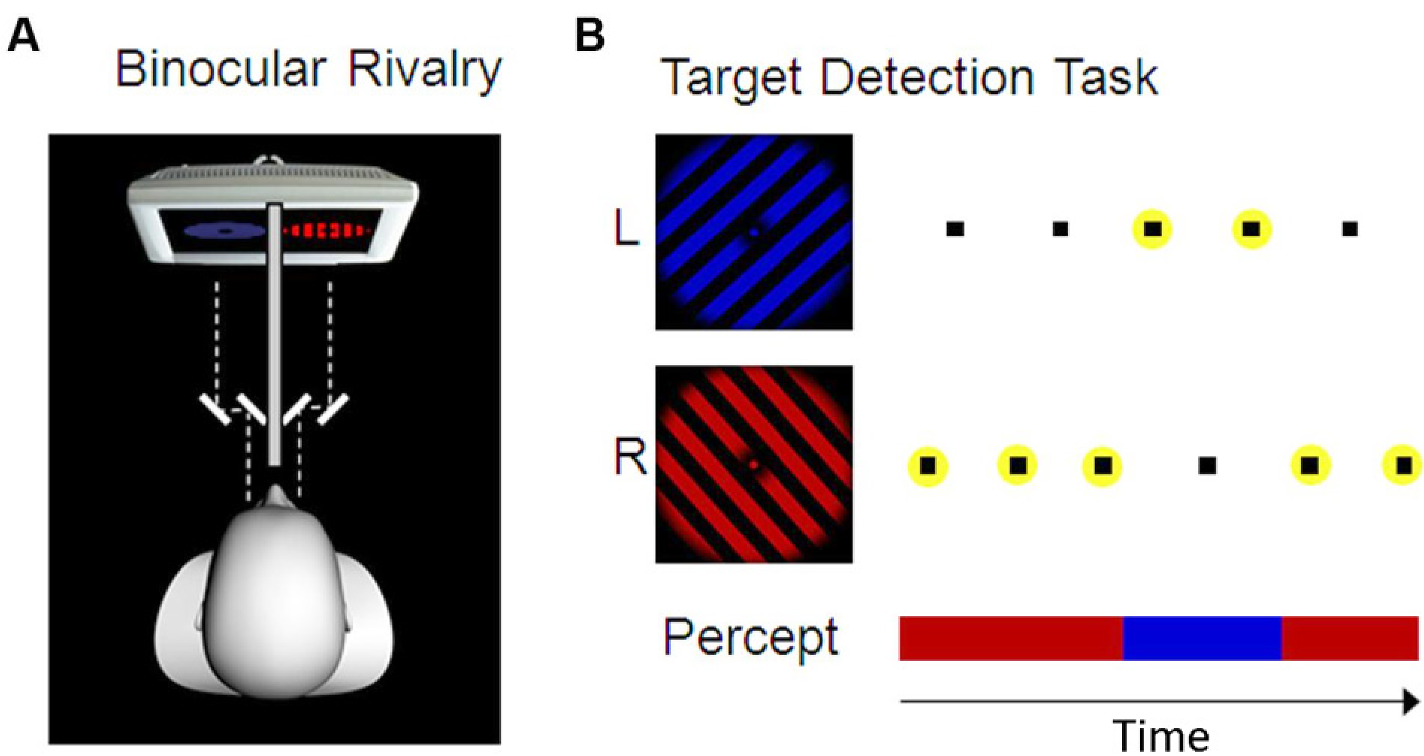


The varieties of visual imagery. Image created by Alia Korot with BioRender.com tasia as a defined variation in neuropsychological function, it still relied on self-reports and observational rather than experimental methods. This original reliance on self-reports created some controversy in the scientific community over whether anyone actually lacked the ability to visualize, or if they simply had poor metacognition– meaning they were unaware of their own visualization. However, various other experiments have supported that individuals with aphantasia do indeed lack imagery capabilities. A test called the binocular rivalry imagery experiment is one empirical way to measure the strength of visual imagery. Participants are told to visualize one of two simple images, then are very briefly presented with those two images in a binocular rivalry display (one image displayed to each eye, for less than a second), then asked which image they saw. Individuals with aphantasia had significantly lower priming scores, meaning they were less likely to preferentially identify the image they had been previously told to visualize (3). These results suggest a much lower vividness and influence of visual imagery, and thus support the presence of aphantasia.

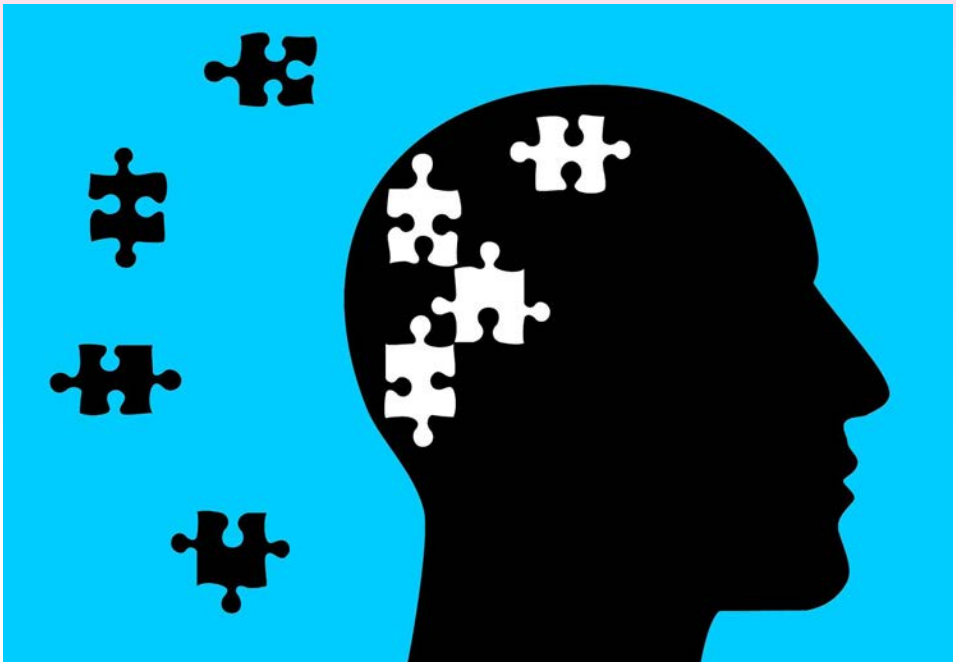
Another empirical way to measure visual imagery is through physiological responses. The pupillary light reflex is a normal response in vision where your pupils constrict when you are seeing something bright. Interestingly, this reflex also occurs with mental visual imagery–when imagining a bright image, your pupils will constrict. However, when individuals with aphantasia are told to imagine images of differing brightness, there is no change in their pupils (2). The normal pupillary light reflex provides some insight on the process of visual imagery itself; namely, that it seems to function through similar pathways to normal visual perception. However, there remain many questions about how exactly imagery is formed in the brain.

Understanding Mental Imagery Using Brain Imaging Techniques

Now that we know there are differences in how well people can visualize, let's try to understand exactly what visual imagery is, and how it works. Visual imagery is used by most people in many of their day-to-day cognitive processes, such as memory, planning, spatial navigation, and reading comprehension. Visual imagery can be voluntary, as in many of the prior processes, or involuntary, such as hallucinations and intrusive images in disorders like schizophrenia and PTSD. This widespread relevance of visual imagery, as well as increasing aware-



Binocular rivalry experiment. Wilbertz G, van Slooten J and Sterzer P, CC BY 4.0 <https://creativecommons.org/licenses/by/4.0>, via Wikimedia Commons ness of the variations in the ability to visualize, has led to recent increased investigation into the neuroscience behind mental imagery. Historically, it has been difficult to study the neural basis of cognitive processes like mental imagery, but the growth of functional brain imaging has created new methods that allow us to begin to see what is happening in our brains when we are told to visualize something.

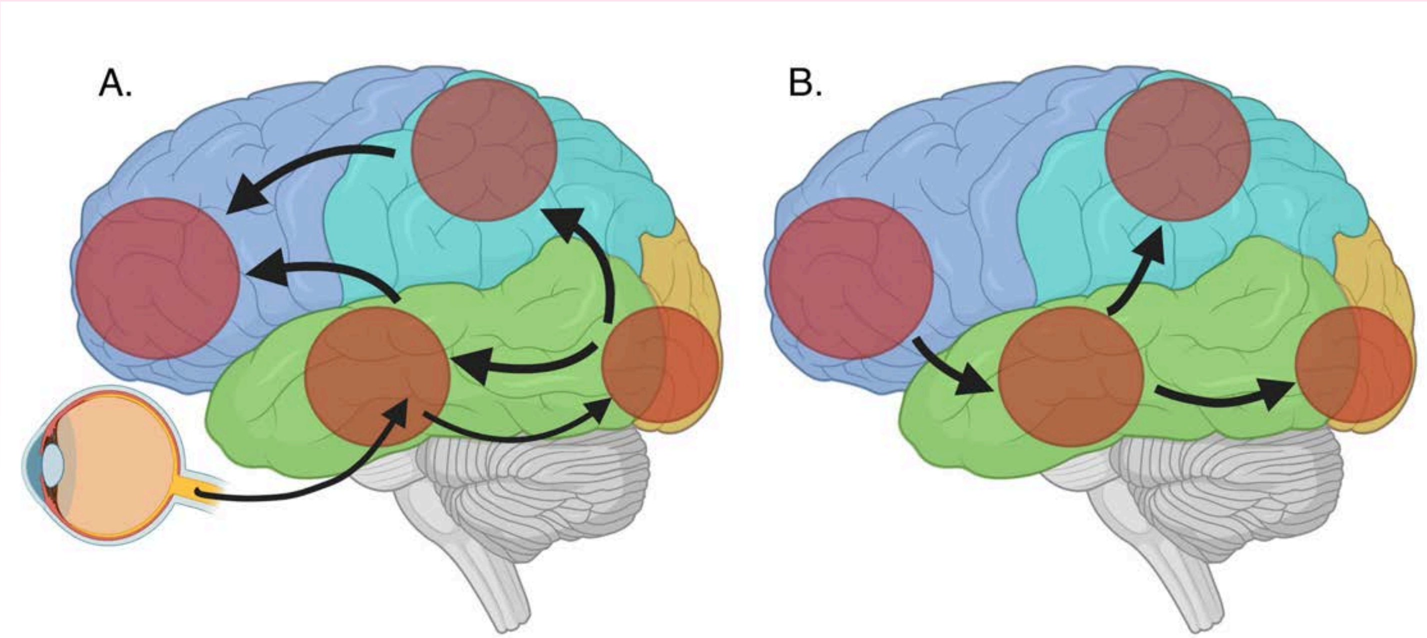


The most important tool that is used in this process is functional magnetic resonance imaging, or fMRI. This technique is safe, noninvasive, and allows scientists and doctors to successfully map and measure brain activity. Magnetic resonance (MR) is the emission or absorption of electromagnetic radiation by an atom in response to a magnetic field. Conducting fMRI on humans involves exposing them to a magnetic field, and measuring MR signals from their brain. Changes in MR signal are indirectly related to changes in blood flow, which reflect changes in neural activity. Thus, when a part of the brain is more active, there is more oxygenated blood flow to this region, so it produces a greater MR signal which can then be mapped and imaged with fMRI (4). With this technology, researchers are able to ask patients to perform certain cognitive tasks and can observe the resulting neural activity. This enables us to understand which parts of the brain are used for different types of thinking and tasks.

Through this use of brain imaging, scientists have further clarified which areas of the brain are involved in voluntary visual imagery. It seems to involve activation of a widespread network in the brain including areas in the prefrontal and visual cortices, similar to those activated in normal visual perception. In vision, visual information enters the brain from the eyes, is relayed to the visual cortex in the occipital lobe, and then enters multiple streams of processing and areas of higher-order functioning (that control thinking, planning, and voluntary behavior). Visual imagery, on the other hand, seems to involve a variety of processes that start at the higher-order areas of the brain, and move down to visual areas. These include decision making, attentional allocation, language processing, and accessing long-term memory—all of which eventually lead to a quasi-visual experience (2). Thus, visual perception and visual imagery seem to utilize similar brain regions, but the flow of activation occurs somewhat in a reverse order, as a more "bottom-up" process for perception versus a "top-down" process for mental imagery. Meaning you consider something in order to perceive it rather than perceiving something, and then considering it.

Amazingly, some detailed brain imaging studies have made it possible to identify what someone is imagining based solely on the pattern of brain activity in their visual cortex! The level of activity measured in the visual cortex also seems to correlate with how vivid someone reports their imagery to be (2). These discoveries highlight how accurately researchers have been able to pinpoint the roles of specific brain regions in visual imagery, though much remains to be discovered.

Now, with a good understanding of the neural activity involved in visual imagery, the next question is how functional brain imaging can help explain the differences in the ability to visualize found in aphantasia. The use of resting state fMRI (in this case, when the brain is not attempting to conjure an image) has been able to successfully elucidate some of the differences in connectivity of brain regions between those with normal imagery, those with hyperphantasia (ultra-vivid imagery), and those with aphantasia. Hyperphantasic individuals show stronger connections between the visual-occipital network and several prefrontal regions compared to those with aphantasia, whereas the aphantasic group shows various other areas of stronger connectivity. Interestingly, these differences in connectivity are similar to those



Neural activation pathways in visual perception vs visual imagery. (A.) depicts the neural activation for the visual perception of an object out in the world, and (B.) depicts the neural activation for the visual imagination of an object. Image created by Alia Korot with BioRender.com. Modified from Pearson, 2019 (11).

previously found in relation to different types of autobiographical memory. People with an episodic (and thus more visual) style of memory show stronger resting state connectivity between important memory regions of the brain and visual areas, while those with a more factual style of memory show greater connectivity between those memory regions and prefrontal regions (5). These findings suggest that there are intrinsic differences in brain connectivity underlying variations in the ability to visualize. There are also differences in brain activity, as hyperphantasic individuals show more activation in certain brain areas when asked to visualize something, in comparison to those with aphantasia (5).

While there have only been a few brain imaging studies on aphantasia so far, the findings have led to some hypotheses about what causes a lack of imagery. One suggested neural mechanism is reduced connectivity between cognitive control systems and the visual areas of the brain. This hypothesis is supported by the fact that many aphantasics still experience visual dreams, an experience in which the imagery is involuntary, suggesting the disconnect is in the voluntary generation of imagery and not the imagery itself (5). This is further supported by individuals with aphantasia not having any difficulty with visual perception; they are simply unable to voluntarily create mental images.

Further Defining Aphantasia

While there is much more to discover about the neural underpinnings of visual imagery and aphantasia, it is also important to further define this phenomenon and its variations. Is it a disorder, a defined and discrete condition? Or just a variation of the human experience, as one extreme end of a continuous spectrum of visual imagery? There is not yet a scientific consensus on this question, and perhaps the answer does not really matter for our understanding of the phenomenon. Definitions will always change, and we can work to understand aphantasia regardless of its classification. There have been reports and previous studies of individuals losing their ability to visualize after injury or disease (known as acquired or neurogenic aphantasia), but individuals with congenital aphantasia (which present at birth), like myself, do not recall ever having the ability to form mental images.

Since congenic aphantasia is present from birth, we must consider the role of genetics in this phenomenon. First degree relatives seem to share aphantasia much more often than would be expected by chance, suggesting heritability which suggests a potential genetic component (2). Around 20% of people with aphantasia are confident they have other family members affected, while nearly 50% are simply unsure (7). Many people simply are not aware of or do not discuss their differences in mental imagery, suggesting that the occurrence of shared aphantasia among relatives could be significantly higher than currently reported. This certainly implies a genetic contribution towards aphantasia, and potentially a strong one, but much more research is required to clarify the strength and details of these genetics.

Another remaining question is whether aphantasia has multiple subtypes,given that people differ on which types of sensory imagery they lack. Some aphantasics lack only visual mental imagery, while others lack all forms of imagery, including auditory, gustatory, and olfactory. Some researchers have suggested a separate name, dysikonesia, for impaired or absent imagery across multiple senses, while reserving aphantasia for the sole lack of visual imagery (6). It remains to be seen whether this term will be more widely adopted, or if aphantasia will simply be generalized to all forms of impaired sensory imagery.

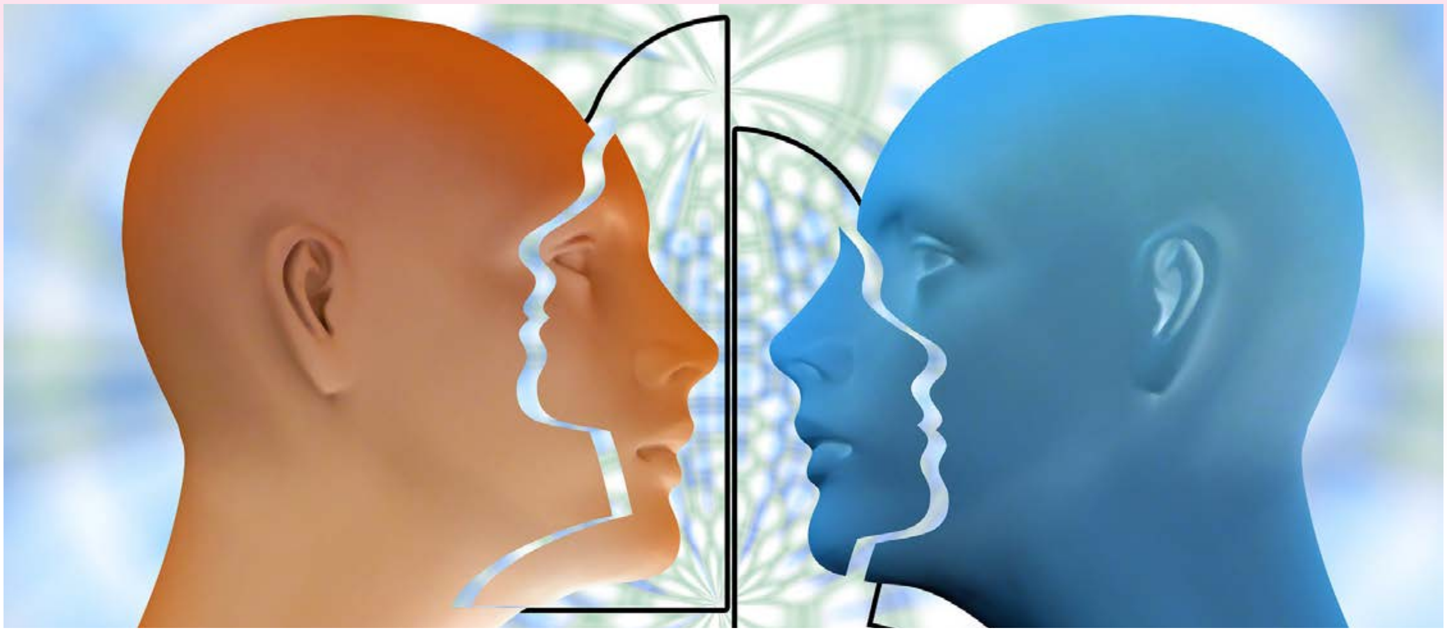
Aphantasia's Impact on Other Cognitive Processes

For those without aphantasia, mental imagery plays a strong role in a variety of cognitive processes. This raises the question of how aphantasia affects other abilities such as memory. The answer seems to be that there are differences in recall and memory, but it depends on the type of memory. Those with aphantasia have equal ability to successfully complete declarative memory tests or even visual working memory tasks (involving using visual information to complete a task). To complete these tasks with no impairments in capacity or accuracy means that aphantasics must rely on different strategies, such as semantic, meaning-based labels and verbal cues rather than visual representations to process visual information (10). These strategies are likely developed throughout life, and perhaps are not developed by those who rely upon mental images. This suggests that visual imagery and working memory are two separate processes, and mental imagery is simply one possible tool that can be used for interpreting and using visual information.

There are some memory tasks that do demonstrate differences between those with and without aphantasia. For example, in one study researchers presented images of real-world scenes to individuals with aphantasia and control participants without aphantasia, and then asked them to draw the scenes from memory. Aphantasic individuals remembered fewer objects, drew with less color, and relied more on symbolic and verbal representations by labeling more objects with words. In contrast, their spatial accuracy in placing objects from the scene was the same as controls (8). These results support the idea that there are separate memory systems for object versus spatial information, and spatial recall is unimpaired in those with aphantasia. Additionally, despite the aphantasic individuals in this study struggling to illustrate a scene from memory, aphantasia certainly does not preclude artistry. There are many self-identified aphantasic visual artists that seem to use strategies that are slightly different from other artists (2).

Autobiographical memory, the memory of your own past, is another area of potential difference. Normally, many people experience their memories of the past through intense, vivid, and movie-like imagery. However, those with aphantasia do not experience their memories in this way. This lack of movie-like imagery seems to translate to diminished autobiographical memory. People with aphantasia report a significantly lower ability to recall specific life events and have very little ability to produce sensory details while remembering events (9). This difference in the ability to remember details of your own past is perhaps the biggest impact of aphantasia, and certainly seems to be a source of distress for many who are aware of it. However, as with other forms of memory, it seems possible for those with aphantasia to learn to rely on other strategies and develop ways to supplement their own memories. If you cannot visualize and relive your life events through imagery in your mind, you thankfully have the ever-present technology of photos and videos to supplement your own memories. Thus, the consequences of aphantasia certainly do not seem too dire and can be overcome with the breadth of other strategies the human imagination is capable of.

For most people, visual imagination is a central part of their lives and seems an intrinsic part of their cognitive experience. As I have discussed my aphantasia with friends and family, I am often met with the reaction that they cannot imagine a mind without imagery. They cannot comprehend how I think and remember and experience the world. Many authors and philosophers over the years have discussed how our vision of our lives, our ability to imagine, and our ability to represent things in their absence is crucial to our human experience—and perhaps what sets us apart as humans. However, these abilities do not rely solely on visual imagery. It was only in the last few years, when I began discussing my cognitive experience with others, that I



discovered that I lack this internal experience that most people rely on. I have certainly never felt that I was missing some necessary part of cognition, and there are many methods of internal representation besides the visual or sensory.

Aristotle once wrote that "the soul never thinks without a phantasm," and he was (and is) far from alone in the assumption that illusory representations and mental imagery are intrinsic to human thought. However, it seems Aristotle was in fact incorrect. He fell into the trap that befalls so many and assumed that his own internal experience resembles all others. Let us not underestimate the many incredible multi-representational abilities of the brain or forget the representational powers of language. Visual imagery is simply one tool in the toolbox of the human brain and lacking it does not prevent the human cognitive experience. I feel I can speak for all those with aphantasia when I say that lacking the ability to visualize does not preclude any complexity of thought or feeling. In this case, I will confidently counter Aristotle and say that my soul certainly does think without a phantasm.

References

1. Zeman, A., Dewar, M., & Della Sala, S. (2015). Lives without imagery - Congenital aphantasia. Cortex; a journal devoted to the study of the nervous system and behavior, 73, 378–380. https://doi.org/10.1016/j.cortex.2015.05.019
2. Keogh, R., Pearson, J., & Zeman, A. (2021). Aphantasia: The science of visual imagery extremes. Handbook of clinical neurology, 178, 277–296. https://doi.org/10.1016/B978-0-12-821377-3.00012-X
3. Keogh, R., & Pearson, J. (2018). The blind mind: No sensory visual imagery in aphantasia. Cortex; a journal devoted to the study of the nervous system and behavior, 105, 53–60. https://doi.org/10.1016/j.cortex.2017.10.012
4. UCSD. (2021). What is fMRI? Center for Functional MRI. Retrieved November 29, 2021, from http://fmri.ucsd.edu/Research/whatisfmri.html.
5. Milton, F., Fulford, J., Dance, C., Gaddum, J., Heuerman-Williamson, B., Jones, K., Knight, K. F., MacKisack, M., Winlove, C., & Zeman, A. (2021). Behavioral and Neural Signatures of Visual Imagery Vividness Extremes: Aphantasia versus Hyperphantasia. Cerebral cortex communications, 2(2), tgab035. https://doi.org/10.1093/texcom/tgab035
6. Dance, C. J., Ward, J., & Simner, J. (2021). What is the Link Between Mental Imagery and Sensory Sensitivity? Insights from Aphantasia. Perception, 50(9), 757–782. https://doi.org/10.1177/03010066211042186
7. Zeman, A., Milton, F., Della Sala, S., Dewar, M., Frayling, T., Gaddum, J., Hattersley, A., Heuerman-Williamson, B., Jones, K., MacKisack, M., & Winlove, C. (2020). Phantasia-The psychological significance of lifelong visual imagery vividness extremes. Cortex; a journal devoted to the study of the nervous system and behavior, 130, 426–440. https://doi.org/10.1016/j.cortex.2020.04.003
8. Bainbridge, W. A., Pounder, Z., Eardley, A. F., & Baker, C. I. (2021). Quantifying aphantasia through drawing: Those without visual imagery show deficits in object but not spatial memory. Cortex; a journal devoted to the study of the nervous system and behavior, 135, 159–172. https://doi.org/10.1016/j.cortex.2020.11.014
9. Dawes, A. J., Keogh, R., Andrillon, T., & Pearson, J. (2020). A cognitive profile of multi-sensory imagery, memory and dreaming in aphantasia. Scientific reports, 10(1), 10022. https://doi.org/10.1038/s41598-020-65705-7
10. Keogh, R., Wicken, M., & Pearson, J. (2021). Visual working memory in aphantasia: Retained accuracy and capacity with a different strategy. Cortex; a journal devoted to the study of the nervous system and behavior, 143, 237–253. https://doi.org/10.1016/j.cortex.2021.07.012
11. Pearson J. (2019). The human imagination: the cognitive neuroscience of visual mental imagery. Nature reviews. Neuroscience, 20(10), 624–634. https://doi.org/10.1038/s41583-019-0202-9