

## Aphantasia and Mathematical Thinking

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## Aphantasia - definition

**Aphantasia** is a condition where one does not possess a functioning “mind’s eye” and cannot voluntarily visualize imagery.

The phenomenon was first described by Francis Galton in 1880, but has since remained largely unstudied. Interest in the phenomenon renewed after the publication of a series of studies begun in 2015 by a team led by Professor Adam Zeman of the University of Exeter, it was in the course of these that the term aphantasia was coined.

Research shows that visual imagery involves a network of brain activity spanning from the frontal cortex all the way to the visual areas at the back of the brain.

Current theories propose that when we imagine something, we reactivate the same pattern of activity in our brain as when we actually saw the image. It might be that aphantasic individuals are not able to reactivate these traces enough to experience visual imagery, or that they use a completely different network when trying to complete tasks involving visual imagery.

However, research is scarce and further studies are called for.

## I'm an aphantasic

A 30 November 2017 article by Keogh and Pearson, *Blind in the mind: why some people can't see pictures in their imagination*, in the 'Conversation' was for me a fascinating eye opener; after over 60 years, it gave me a name, [congenital aphantasia](#), for something I have known about myself from an early age and confirmed that I am not unique in this way.

Although now a research mathematician, who broadly describes himself as a 'geometer', early in my primary school years I had a growing awareness that instructions such as: "picture ...", "imagine you are looking at...", "recall what ... looks like" triggered something quite different in most people than they did for me.

For me these were mere figures of speech, that drew visual blanks. I have never been able to conjure up (recall or create) "mental images" that are experientially essentially indistinguishable from visually stimulated ones, though I have long suspected others might be able to.

Indeed, I soon inferred that for others the sensation(s) evoked when "picturing something" differed little from what they experienced when actually looking at it. For me it is more as if I were in a completely darkened room, but one that had been accurately described to me so that I knew everything that is in there and where they are located - I could imagine pointing/reaching out to them, even manipulating them.

Though, I realize that someone without aphantasia might never be truly in the dark; after the lights have been switched off, they could populate it with images recalled from before it was darkened. The sensation I experience is like when I was in my father's darkroom and having put a roll of film down knew later, without ever having seen it placed on the bench top, exactly where to reach for it.

## Visual input

Here is a page of my mathematical working

$$x_{n+1} = \frac{1}{2} (I + (2P_B - I)(2P_A - I)) x_n$$

$$= \frac{1}{2} (I + 2P_B(2P_A - I) - 2P_A + I) x_n$$

$$= (I + 2P_B P_A - P_B - P_A) x_n$$

$$= (I + 2P_B P_A - (P_A + P_B)^2 - P_A P_B - P_B P_A) x_n$$

$$= (I + P_B P_A - P_A P_B - (P_A + P_B)^2) x_n$$

$$= I + 0 + 0 - I$$

$$= 0$$

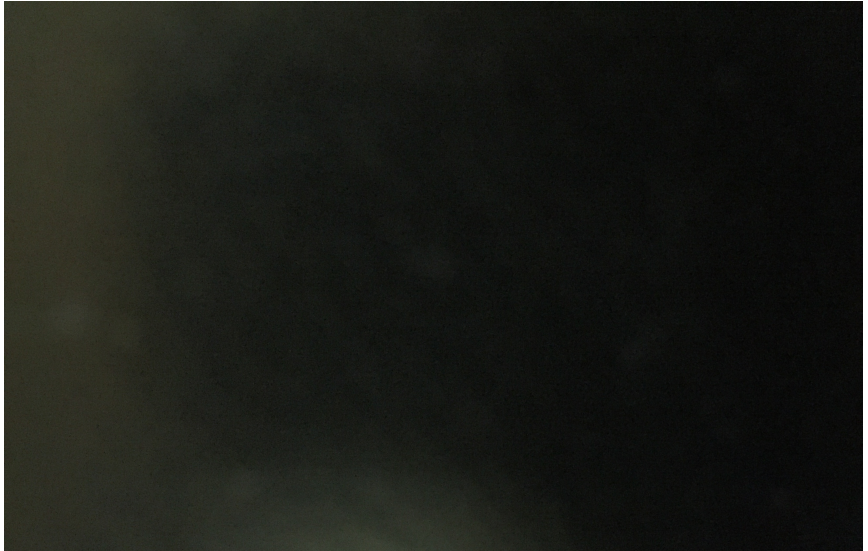
$(P_A + P_B)^2 = P_A + P_B + P_A P_B + P_B P_A$

$P_A + P_B = I \quad P_B P_A = P_B (I - P_B) = 0$

When I close my eyes or look away and try to recall it this is what I “see”:



## The blind mind's eye



## What do I recall!

I have a clear awareness of what comprised the diagram and can imagine the effects of manipulating it.

Less so of the algebraic calculations, unless I'd made a concerted effort to memorize them (as verbal sentences).

This raises the question:

How does aphantasia affect doing mathematics?

Psychologists have learned much about the functioning of the human mind from the study of those with abnormal conditions (epilepsy, schizophrenia, ...), research greatly enhanced by advances in brain chemistry and neural imaging.

Might aphantasia be a tool to help better understand the ways and processes of mathematical thinking?

## Maths and aphantasia

I know of one other mathematician with aphantasia, but suspect there may be many others, as at least 2% of people are believed to have aphantasia.

Two of my five children also report having aphantasia, so I'm surmising it is likely a genetic condition.

Here is some email dialogue with my eldest son, Aidan, also a mathematician (but not an aphantasic) at University of Wollongong, concerning the effect of aphantasia on how one does mathematics.

From Aidan: I'd love to have a clearer idea of how you go about mathematics without mental pictures. Almost all of my reasoning when I'm proving something involves having a mental picture that I "look at" to see what I think ought to be true and why, and then trying to translate that into a formal argument. I wonder if this is why you are so much better at analysis than me whereas I tend to be much more geometry/topology-oriented.

My reply: How, aphantasia impacts (my) doing maths is an absolutely intriguing question, and one I would love to see researched. I have often wondered what difference it would make to how others might work if they were truly able to conjure visual images from their mind, as if equipped with a mental blackboard.

## More

My first love in mathematics was the rather large dose of [Euclidean geometry](#) that occupied half of the first three years of the high school mathematics curriculum and at which I always excelled.

Next, was [vector geometry](#), first encountered in first year university (I had done 2 and 3 dimensional coordinate geometry at school, but being able to capture it "descriptively" in terms of vectors and vector operations was a revelation).

Followed by [metric topology](#) in second year.

I too have always thought of myself as being geometry/point set topology oriented. Even my perception and understanding of analysis is geometric in flavour, underpinned by concepts such as a continuum, special subsets of  $\mathbb{R}^n$ , graphs, neighbourhoods of points, etc.

## and more

I believe my brain stores the same information as other peoples' brains do (else how could I recognise someone, something or somewhere when I encounter it again, or describe in words details of a scene I have glimpsed - things that I have always been able to do rather well). But, I recall, process and operate on such stored information differently; **SOMEHOW** without experiencing the sensations of visual imagery.

It seems to me likely that this freedom from the precision and detail of a visual image is a boon to my ability to think and work abstractly.

## and yet more

Where I do feel a lack of being able to conceive visual images on which to work is a handicap is in anticipating and seeing through a symbolic/algebraic argument, or carrying out any lengthy algebraic computations/manipulations in my head - something I have always been rather poor at without recourse to pen and paper (perhaps the explanation for my always wanting a pen at hand).

Without making the effort to commit details to memory, I cannot refer back to earlier steps of a calculation, nor am I good at anticipating to what algebraic manipulations may lead.

## otherwise I'm normal

Otherwise, however, my mathematical performance is in tune with that described by Hadamard and attested to by many others:

the addictive exhilaration one experiences when the pieces suddenly come together and the way this happens,

hours, weeks, even years spent mastering material together with countless assaults on the problem until it becomes an old friend, or more likely foe. Then that gestalt moment when, as a fait accompli, into your consciousness pops a key insight via which a solution tumbles into place, or the details of an argument present themselves, accompanied by complete certainty (frequently misplaced) of their correctness.



## More on me

In conclusion, here are some other things you may, or may not, want to know about me.

My dreams are populated with vivid colour imagery, so blindness in the mind's eye does not apply when dreaming. I'm an avid reader enjoying both nonfiction and fiction, especially works in the fantasy genre.

I can sketch, draw and paint tolerably well, and enjoy doing so, but have never been good at capturing faces, even when the subject is sitting for me.

Once having been somewhere I can usually find my way back again without difficulty.

Woodwork (and other DIY tasks) have been a lifelong hobby. I successfully make furniture, toys and the like having designed, chosen materials, and scheduled the necessary order of construction in my head without recourse to sketches or plans.

## Some references

- 1 Aphantasia (non-imager/mental blindness) awareness group, Facebook.
- 2 Rebecca Keogh and Joel Pearson, *Blind in the mind: why some people can't see pictures in their imagination*, The Conversation; November 30, 2017.
- 3 Rebecca Keogh and Joel Pearson, *The blind mind: No sensory visual imagery in aphantasia*, Cortex (2017), doi: [10.1016/j.cortex.2017.10.012](https://doi.org/10.1016/j.cortex.2017.10.012).
- 4 *The eye's mind*, University of Exeter, [sites.exeter.ac.uk/eyesmind](http://sites.exeter.ac.uk/eyesmind) - and material accessible therein.
- 5 Mental images, Wikipedia, [https://en.wikipedia.org/wiki/Mental\\_image](https://en.wikipedia.org/wiki/Mental_image)
- 6 Mia Tomova, *Experience; I can't picture things in my mind*, The Guardian, 4 August 2018, <https://www.theguardian.com/lifeandstyle/2018/aug/24/experience-i-cant-picture-things-in-my-mind>.