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Lives without imagery – congenital aphantasia

Adam Zeman[a], Michaela Dewar[b], Sergio Della Sala[c]

[a] Professor of Cognitive and Behavioural Neurology, University of Exeter Medical School, College House, St Luke's Campus, Exeter EX1 2LU (corresponding author)

a.zeman@exeter.ac.uk

[b]Assistant Professor and Research Leader, Psychology, School of Life Sciences, Heriot-Watt University, Edinburgh EH14 4AS

m.dewar@hw.ac.uk

[c]Professor of Human Cognitive Neuroscience, Human Cognitive Neuroscience, University of Edinburgh, 7 George Square, Edinburgh EH8 9JZ

sergio@ed.ac.uk

1. Introduction

Visual imagery is, for most of us, a conspicuous ingredient of everyday experience, playing a prominent role in memory, daydreaming and creativity. Galton, who pioneered the quantitative study of visual imagery with his famous 'breakfast-table survey', reported a wide variation in its subjective vividness (Galton, 1880). Indeed, some participants described 'no power of visualising'. This phenomenon has received little attention since, though Faw reported that 2.1-2.7% of 2,500 participants 'claim no visual imagination' (Faw, 2009).

The experience of voluntary imagery is associated with activity in fronto-parietal 'executive' systems and in posterior brain regions which together enable us to generate images on the basis of our stored knowledge of appearances (Bartolomeo, 2008). The relative contributions of lower and higher order visual regions to the experience of visual imagery are debated (Bartolomeo, 2008). Clinical reports suggest the existence of two major types of neurogenic visual imagery impairment: i) visual memory disorders, causing both visual agnosia and imagery loss, and ii) 'imagery generation' deficits selectively disabling imagery (Farah, 1984).

In 2010 we reported a particularly 'pure' case of imagery generation disorder, in a 65 year old man who became unable to summon images to the mind's eye after coronary angioplasty (Zeman et al., 2010). Following a popular description of our paper (Zimmer, 2010), we were contacted by over twenty individuals who recognised themselves in the article's account of 'blind imagination', with the important difference that their imagery impairment had been lifelong. Here we describe the features of their condition, elicited by a questionnaire, and suggest a name – *aphantasia* - for this poorly recognised phenomenon.

2. Results

21 individuals contacted us because of their lifelong reduction of visual imagery. We explored the features of their condition with a questionnaire devised for the purpose and the Vividness of Visual Imagery Questionnaire (VVIQ) (Marks, 1973) (*see supplementary material for further details*). Participants typically became aware of their condition in their teens or twenties when, through conversation or reading, they realised that most people who 'saw things in the mind's eye', unlike our participants, enjoyed a quasi-visual experience. 19/21 were male. 5/21 reported affected relatives. 10/21 told us that all modalities of imagery were affected. Our participants rating of imagery vividness was significantly lower than that of 121 controls ($p<.001$, Mann Whitney U test – see Figure 1). Despite their substantial (9/21) or complete (12/21) deficit in voluntary visual imagery, as judged by the VVIQ, the majority of participants described involuntary imagery. This could occur during wakefulness, usually in the form of 'flashes' (10/21) and/or during dreams (17/21). Within a group of participants who reported no imagery while completing the VVIQ, 10/11 reported involuntary imagery during wakefulness and/or dreams, confirming a significant dissociation between voluntary and involuntary imagery ($p<.01$, McNemar Test). Participants described a varied but modest effect on mood and relationships. 14/21 participants reported difficulties with autobiographical memory. The same number identified compensatory strengths in verbal, mathematical and logical domains. Their successful performance in a task that would normally elicit imagery – 'count how many windows there are in your house or apartment' - was achieved by drawing on what participants described as 'knowledge', 'memory' and 'subvisual' models.

3. Discussion

φαντασία, phantasia, is the classical Greek term for imagination, defined by Aristotle as the 'faculty/power by which a *phantasma* [image or mental representation] is presented to us' (Aristotle, 1968). We propose the use of the term 'aphantasia' to refer to a condition of reduced or absent voluntary imagery. Terms used previously in related contexts include 'defective revisualisation' (Botez, Olivier, Vezina, Botez, & Kaufman, 1985) and 'visual irreminiscence' (Nielsen, 1946).

Sceptics could claim that aphantasia is itself a mere fantasy: describing our inner lives is difficult and undoubtedly liable to error (Hurlburt & Schwitzgebel, 2007). We suspect, however, that aphantasia will prove to be a variant of neuropsychological functioning akin to synaesthesia (Barnett & Newell, 2008) and to congenital prosopagnosia (Gruter, Gruter, Bell, & Carbon, 2009). Indeed, aphantasia may have some specific relationship to these disorders, as congenital prosopagnosia is associated with unusually low (Gruter et al., 2009), and synaesthesia with unusually high (Barnett & Newell, 2008), VVIQ scores.

The participants described here were self-selected and some of our findings, such as the male predominance, may reflect the readership of a science magazine like *Discover*. There is a need, therefore, for further study in a more representative sample. The existence of lifelong 'aphantasia' raises numerous additional questions. How commonly does congenital aphantasia occur? Existing data suggest a frequency of around 2% but there is no fully reported large scale study. The evidence of familial occurrence should be investigated further. Does congenital aphantasia have objective neuropsychological associations? Correlations between imagery vividness and cognitive functioning have been elusive in the past, but recently developed measures of autobiographical memory (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002), imaginative thinking and 'visual-object intelligence' (Blazhenkova &

Kozhevnikov, 2010) open up new avenues for exploration. Personality and mood may also be relevant variables. Are there subtypes of congenital aphantasia? The descriptions given by our participants suggest that in some cases visual memory is preserved even if visual imagery is absent, while others may rely entirely on non-visual representations in memory tasks; the relationship between aphantasia and congenital prosopagnosia also deserves further study. If, as we hypothesise, the absence or reduction of visual imagery has neural correlates, can we discover these? We are optimistic that modern structural and functional brain imaging may help to answer questions about the nature of visual imagery that were first posed in ancient Greece and first quantified at Sir Francis Galton's breakfast table over a hundred years ago.

Figure legend

Figure 1: Distribution of Vividness of Visual Imagery Questionnaire (VVIQ) scores in participants with aphantasia and control participants (VVIQ range extends from 16, lowest imagery score to 80, highest imagery score).

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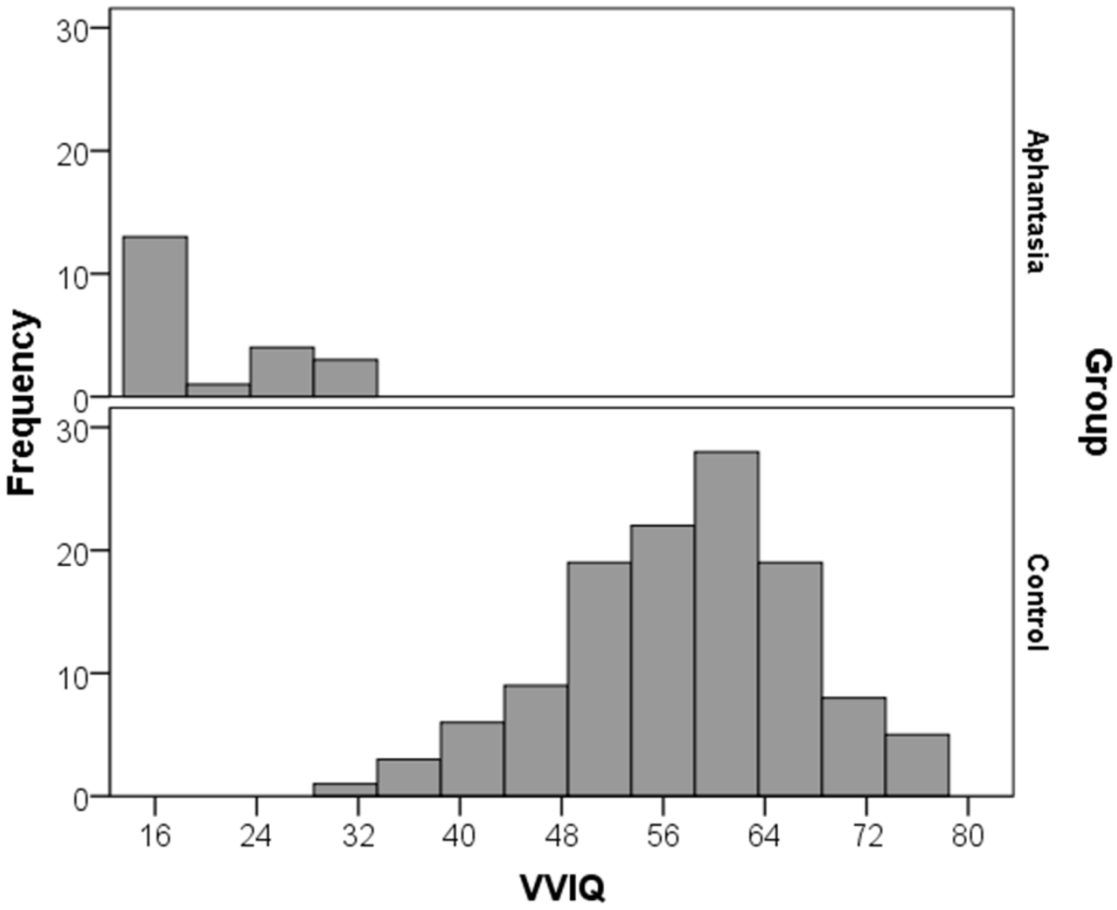

Figure 1 VVIQ in people with aphantasia and control participants

Lives without imagery – congenital aphantasia

Supplementary data

1. Material sent to participants

1.1 Email sent to people who contacted us to say that they lacked visual imagination

I am writing in response to your message about Carl Zimmer's article in Discover on visual imagination. I am the first author of the paper Carl Zimmer's article referred to.

You were one of around 15 people who made contact following this article to report that – in most instances - you had *never* experienced visual imagery (while, of course, the patient we describe, MX, had experienced vivid visual imagery until he lost it abruptly in mid-life).

Although it has been recognised since the 19th century that some people get along very well without having the experience of visual imagery, surprisingly little scientific attention has been paid to this fascinating fact.

If you are willing to help us, my co-authors and I felt that we should take this unexpected opportunity to learn a little more about visual imagery – and its absence.

I am attaching two short questionnaires. I would be very grateful if you could complete and return these electronically.

The first is newly created, and asks a range of questions about matters connected with imagery, for example whether your dreams contain visual imagery. These questions are often raised when imagery is discussed, and we hope that your answers will help to clarify the experience of people who lack imagery.

The second is a widely used 'vividness of visual imagery questionnaire'. We expect you to rate your imagery at the low end of the spectrum – given what you have written – but it would be helpful to quantify your experience using this standard measure.

We have been studying imagery in normal folk to follow up our work with MX. We anticipate putting the data we have gathered from these participants together with what we learn from your answers to write a paper drawing attention to the neglected phenomenon you have described. Looking to the future, as we now have tools to study the working brain in action, it should soon be possible to discover why there is such a wide variation in the vividness of imagery. Your responses will highlight the variation we need to explain.

Any information you provide will be used in an anonymous fashion. Unless you prefer not to be informed, I will keep you in touch with the results of this small survey, and send you a copy of any publication that results.

Many thanks for contribution so far, and for helping with this work.

Best wishes

Adam

1.2 Newly devised imagery questionnaire emailed to participants with response letter above

Age

Years of full-time education

Profession

When did you become aware that you were unable to form mental images?

How did you become aware of this?

Did this discovery have an emotional impact on you?

Is your lack of visual imagery total, or do you sometimes experience brief flashes of imagery?

Is your ability to imagine affected by whether your eyes are open or closed?

Are all types of imagery affected, or can you imagine sounds (including music), textures (by imagined touch), tastes or smells?

Do you dream normally, and in particular do you see visual images in dreams?

Is your ability to recall memorable events from the past, like holidays or celebrations, normal?

Do you think that your lack of a 'mind's eye' has had any other effect on your thought processes?

Did it affect your career choice?

Has it had an effect on your relationships (for example by making it more difficult to reminisce, or to imagine the faces of loved ones)?

Do you think that your lack of a mind's eye has had any particular advantages?

Do you have any relatives who have similarly noticed that they lack a mind's eye?

Please count the number of windows in your house or apartment. How do you do this? Do you inspect an image of your house or apartment as you perform this task?

Do you have any other comments?

Thank you very much for your help!

1.3 ***Vividness of visual imagery questionnaire sent to participants with response letter above***

VIVIDNESS OF VISUAL IMAGERY QUESTIONNAIRE (VVIQ)

For each item on this questionnaire, try to form a visual image, and consider your experience carefully. For any image that you do experience, rate how vivid it is using the five-point scale described below. If you do not have a visual image, rate vividness as '1'. Only use '5' for images that are truly as lively and vivid as real seeing. Please note that there are no right or wrong answers to the questions, and that it is not necessarily desirable to experience imagery or, if you do, to have more vivid imagery.

Perfecting clear and lively as real seeing	5
Clear and lively	4
Moderately clear and lively	3
Dim and vague; flat	2
No image at all, you only "know" that you are thinking of the object	1

For items 1-4, think of some relative or friend whom you frequently see (but who is not with you at present) and consider carefully the picture that comes before your mind's eye.

1. The exact contour of face, head, shoulders and body _____
2. Characteristic poses of head, attitudes of body etc. _____
3. The precise carriage, length of step etc., in walking _____
4. The different colours worn in some familiar clothes _____

Visualise a rising sun. Consider carefully the picture that comes before your mind's eye.

5. The sun rising above the horizon into a hazy sky _____
6. The sky clears and surrounds the sun with blueness _____
7. Clouds. A storm blows up with flashes of lightning _____
8. A rainbow appears _____

Think of the front of a shop which you often go to. Consider the picture that comes before your mind's eye.

9. The overall appearance of the shop from the opposite side of the road _____
10. A window display including colours, shapes and details Of individual items for sale _____
11. You are near the entrance. The colour, shape and details of the door. _____
12. You enter the shop and go to the counter. The counter Assistant serves you. Money changes hands _____

Finally think of a country scene which involves trees, mountains and a lake. Consider the picture that comes before your mind's eye. _____

13. The contours of the landscape _____
14. The colour and shape of the trees _____
15. the colour and shape of the lake _____
16. A strong wind blows on the trees and on the lake causing reflections in the water. _____

2.0 Control participants

Control results for the VVIQ were obtained previously from two groups of healthy participants: 111 healthy Psychology undergraduates and 10 healthy middle-aged professional men (all surveyors or architects chosen to match the profession of our 2010 patient (Zeman et al., 2010)). We use their scores for comparison with those in our participants below.

3.0 Questionnaires

We used the two questionnaires provided above. We note that we used a modified version of the VVIQ in which more vivid imagery is, intuitively, assigned a higher score. In the original version, higher scores were assigned to less vivid imagery (Marks, 1973). Scores on the 5-point scale can be straightforwardly converted between the two scoring systems by subtraction from 6.

4.0 Aphantasia Subgroups

We distinguished two aphantasia subgroups based on participants' self-rating for vividness of imagery (VVIQ): i) a 'no imagery' group (N = 12) containing participants who responded 'no image at all' across all VVIQ tasks, resulting in the lowest possible VVIQ score of 16; ii) a 'minimal imagery' group (N = 9) containing participants with a VVIQ score greater than 16 (range = 17 – 30).

5.0 Statistical Methods

We used IBM SPSS 21 to analyse our data. As VVIQ scores are ordinal, we applied the non-parametric Mann-Whitney U test (two-tailed) (i) to compare the sample's VVIQ scores to those of the control samples, and (ii) to compare VVIQ scores in the two aphantasia subgroups. We applied one-way ANOVAs (two-tailed) to compare the two aphantasia subgroups' age and education, and the Fisher exact test (two-tailed) to compare their binary (Yes/No) questionnaire data. We used the McNemar test to compare, within-subjects, voluntary and involuntary imagery in the 'no imagery' aphantasia subgroup. Effect sizes were determined using r (.1 = small effect, .3 = medium effect, .5 =

large effect) for the Mann-Whitney U tests, Cohen's d (.2 = small effect, .5 = medium effect, .8 = large effect) for the one-way ANOVAs, and phi (.1 = small effect, .3 = medium effect, .5 = large effect) for Fisher exact tests (Cohen, 1988).

6.0 Results

The aphantasia groups' descriptive data are shown in Table 1 (see end of document). The full aphantasia group's VVIQ scores (median = 16) differed significantly from those of the 111 psychology student controls (median = 58) ($p < .001$, U = 0, $r = -.63$), from those of the 10 middle-aged male architects and surveyors (median = 65) ($p < .001$, U = 0, $r = -.82$), and from those of the two control groups combined (median = 59) ($p < .001$, U = 0 $r = -.61$, see Figure 1). For comparison, in his meta-analysis McKelvie (1995) calculated a mean VVIQ of 59.2 (SD = 11.07) among 1869 participants. The equivalent VVIQ means for our controls (students = 58, middle-aged architects and surveyors = 66, two groups combined = 57.92) are similar to this mean VVIQ score.

The two aphantasia subgroups' data are also shown in Table 1 (at end). The two subgroups did not differ significantly in age (no imagery group: mean = 39.92, SD = 14.03; minimal imagery group: mean = 44.25, SD = 15.73; $F(1, 18) = .416$, $p = .527$, Cohen's $d = -.29$) or in years of education (no imagery group: mean = 16.83, SD = 4.13; minimal imagery group: mean = 15.88, SD = 2.17; $F(1, 18) = .360$, $p = .556$, Cohen's $d = .29$). VVIQ scores were significantly higher in the 'minimal imagery' group (median = 26) than in the 'no imagery' group (median = 16) ($p < .001$, U = 0, $r = .93$). Participants in the 'no imagery' group were more likely than those in the 'minimal imagery' group to report a total lack of wakeful visual imagery in our questionnaire (6/12 vs 0/9, $p < .05$, *phi* = -.55, Fisher's exact test). More participants in the 'minimal imagery' (4/9) than 'no imagery' (0/12) group reported that their visual imagery was affected by eye closure ($p < .05$, *phi* = .56, Fisher's exact test). No further subgroup comparisons were significant (all $p > .153$). In order to explore the contrast between voluntary imagery and involuntary imagery we compared, within the 'no imagery' subgroup, the number of participants reporting voluntary imagery (in VVIQ) and involuntary imagery

(in questionnaire). One participant did not answer the question regarding visual imagery during dreams, resulting in a sample n of 11. Whereas none of the 'no imagery' participants (0/11) were able to summon up visual images in the VVIQ test (voluntary imagery), almost all of them (10/11) reported involuntary imagery during wakefulness and/or dreams, and this dissociation was significant ($p < .01$, McNemar test).

7.0 Acknowledgements

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Table 1 Demographic features and questionnaire results in participants with aphantasia

Measure	Full sample (n=21)	'No imagery' (n=12)	'Minimal imagery' (n=9)
	Sample means (SD)		
Age	41.65 (14.49)	39.92 (14.03)	44.25 (15.73)
Education	16.45 (3.44)	16.83 (4.13)	15.88 (2.17)
Age aware	29.5 (15.57)	26.91 (11.37)	32.67 (19.84)
	Sample medians		
VVIQ	16 (mean = 19.9)	16 (mean = 16)	26 (mean = 25.11)
	Sample frequencies		
Sex ratio (M:F)	19:2	11:1	8:1
Trigger event	18 (85.7%)	10 (83%)	8 (88.9%)
Emotional impact	8 (38.1%)	6 (50%)	2 (22.2%)
Total lack of imagery	6 (28.6%)	6 (50%)	0
Flashes of imagery	10 (47.6%)	5 (41.7%)	5 (55.6%)
Effect of eye closure	4 (19%)	0	4 (44.4%)
All senses affected	10 (47.6%)	7 (58.3%)	3 (33.3%)
Visual images in dreams	17 (81%)	10 (83.3%)	7 (77.8%)
Normal autobiographical memory	7 (33.3%)	4 (33.3%)	3 (33.3%)
Effect on cognition	13 (61.9%)	8 (66.7%)	5 (55.6%)
Effect on career choice	5 (23.8%)	2 (16.7%)	3 (33.3%)
Effect on relationships	7 (33.3%)	3 (25%)	4 (44.4%)
Advantages of imagery deficit	14 (66.7%)	9 (75%)	5 (55.6%)
Relatives affected	5 (23.8%)	1 (8.3%)	4 (44.4%)
Window counting - inspect image	2 (9.5%)	0	2 (16.7%)

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