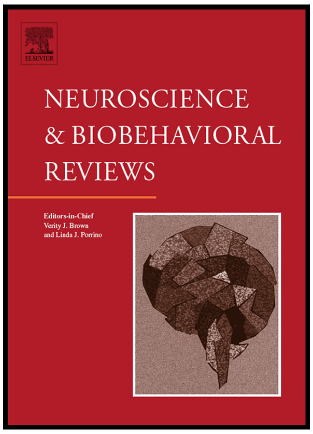

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Phantasia, aphantasia, and hyperphantasia: empirical data and conceptual considerations

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Abstract
Within the past decade, the term "phantasia" has been increasingly used to describe the human capacity, faculty, or power of visual mental imagery, with extremes of imagery vividness characterised as "aphantasia" and "hyperphantasia". A substantial volume of empirical research addressing these constructs has now been published, including attempts to find inductive correlates of behaviourally defined aphantasia, for example using research questionnaires and functional magnetic resonance imaging. Mental imagery has long been noted as a source of conceptual confusions but no specific conceptual analysis of the new formulation of phantasia, aphantasia, and hyperphantasia has been undertaken hitherto. We offer some conceptual considerations on phantasia, noting the ongoing confusion of perceptual with mental images, and the ubiquitous use of unvalidated subjective assessment instruments such as the Vividness of Visual Imagery Questionnaire (VVIQ) in diagnosis and assessment, development of which was predicated on these conceptual confusions. We offer some suggestions for a conceptual framework for future empirical studies in this field, circumventing these conceptual confusions.

Keywords: aphantasia; fantasia; hyperphantasia; mental imagery; phantasia

1. Introduction

The term "aphantasia" was coined to describe individuals with reduction, absence, or loss of the faculty of visual mental imagery. Subsequently a condition of hyperphantasia was defined as an abundance or a "photo-like" quality of visual imagery. Aphantasia and hyperphantasia have thus been characterised as the extremes of phantasia, or visual imagery vividness (Keogh et al., 2021).

The purpose of this article is to survey briefly the clinical phenomenology and research investigations of phantasia, aphantasia and hyperphantasia as a prelude to offering a conceptual analysis of these terms. The empirical data are then reconsidered in light of the conceptual analysis.

2. Empirical data

2.1 Clinical diagnosis

The term “aphantasia” was first coined to describe the findings in a series of 21 individuals self-reporting a lifelong reduction in, or the absence of, the faculty of visual mental imagery (Zeman et al., 2015). This study built on a previous case report of a patient, “MX”, who abruptly lost experiential visual imagery following a coronary angioplasty procedure (Zeman et al., 2010). This report was noted in a popular science magazine (Zimmer, 2010) which then prompted the 21 individuals to present themselves for further study.

The development of a neologism to describe “reduced or absent voluntary imagery” (as compared to its loss in MX) was prompted by the belief that the phenomenon had been “poorly recognised” hitherto (Zeman et al., 2015). The only prior citations were to Sir Francis Galton (1822-1911), whose studies of visual imagery in the 1880s had noted that some individuals had “no power of visualising” (Galton, 1880; 1883), and to a report of individuals who “claim no visual imagination” (Faw, 2009).

Another prior case had been presented by Oliver Sacks (1933-2015) in his book *The Mind’s Eye*. He described a Boston vascular surgeon who became aware of his lack of visual imagery whilst participating in some psychological tests whilst a student at Harvard. Reportedly “no one in his family” had any visual imagery. Sacks stated that he, too, had no voluntary visual imagery but did experience involuntary imagery in dreams and in migraine aura. He suggested that “One must infer, as my colleague in Boston does, that we, too have visual images, models, and representations in the brain, images that allow visual perception and recognition but are below the threshold of consciousness” (Sacks, 2010).

Awareness of aphantasia often becomes apparent only when the individual learns from discussion with others, or increasingly through social media, about the existence of a capacity or faculty for visual mental imagery, having understandably accepted hitherto their own subjectivity as normal. Studies have suggested a population prevalence of aphantasia of around 4% (Dance et al., 2022), although discrepancies in prevalence between self-report and imagery questionnaire scales have been noted (Beran et al., 2023). The possibility that aphantasia might run in families, as suggested by Sacks (2010) and in the original Zeman et al. (2015) series in which 5/21 patients reported affected relatives, appears to have been born out in a larger study of more than 2000 self-reported individuals in which aphantasia ran in families more often than would be expected by chance. In addition, aphantasia has been reported to be associated with difficulty with face recognition and autobiographical memory, and aphantasics are apparently more likely to pursue scientific and mathematical occupations (Zeman et al., 2020). Aphantasics have also been reported to have more autistic traits (Dance et al., 2021a) or higher scores on the Autism Quotient measure (Milton et al., 2021) than controls.

A condition designated “hyperphantasia” has also been described, characterised by an abundance (Zeman et al., 2020) or a “photo-like” quality (Keogh et al., 2021) of visual imagery. Aphantasia and hyperphantasia are thus held to represent the extremes of phantasia, or visual imagery vividness, bracketing those with “midrange imagery vividness” (Milton et al., 2021). In a study of over 200 individuals with self-reported hyperphantasia there was an elevated rate of synaesthesia (although this may also occur with aphantasia; Dance et al., 2021a) and an association with “creative” professions (Zeman et al., 2020). As an example, it has been suggested that the artist William Blake (1757-1827), noted for the “visions” which formed the basis for his illustrations of his poetry, might have had hyperphantasia (Glynn, 2021).

Loss or diminution of visual imagery may be congenital or developmental, as in the cases reported by Sacks (2010) and by Zeman et al. (2015), and apparently by Galton (1880, 1883) and Faw (2009), or may be acquired as a consequence of brain pathology. The clearest examples of acquired aphantasia relate to cases with neuroradiologically confirmed findings of stroke (Thorudottir et al., 2020; Patient PL518). Stroke has also been implicated in cases following coronary angioplasty (Zeman et al. 2010; patient "MX"), stem cell transplantation (Bumgardner et al., 2021), and COVID-19 infection (Gaber and Eltemamy, 2021), although the possibility of immunologically-mediated mechanisms has also been raised.

Reports of acquired loss or diminution of visual imagery may date back to the nineteenth century, specifically the case of "Monsieur X" reported by Charcot and Bernard (1883). The case was discussed by Nielsen (1958) but without crediting Bernard. Young and van de Wal (1996) thought the nature of this patient's impairment was probably hybrid, with loss of ability to generate visual images and a form of prosopagnosia. Conversely, visual mental imagery may be preserved despite acquired visual perceptual deficits (e.g. agnosia, alexia, achromatopsia, prosopagnosia with bilateral temporo-occipital cortical lesions; Bartolomeo et al., 1998). A functional or psychiatric rather than neurological explanation for the symptoms of "Monsieur X" has also been suggested (Zago et al., 2011). The possibility that aphantasia might be a psychogenic disorder has also been considered by other authors (de Vito and Bartolomeo, 2016). Other reports suggestive of loss or diminution of visual imagery but predating the coining of the term "aphantasia" have been identified (e.g. Nielsen, 1946; Brain, 1954; Botez et al., 1985).

Zeman et al. (2015) found that the majority of individuals with congenital aphantasia described involuntary imagery during dreams (17/21) and this was confirmed in a larger study (N = 2000) which reported that "the majority dream visually" (Zeman et al., 2020), although less frequent and less vivid night dreams have been reported in aphantasics (Dawes et al., 2020; Beran et al., 2023). Hence, visual imagery is not completely lost or diminished in so-called aphantasics, since involuntary imagery is often preserved (although this view has recently been contested; Krempel and Monzel, 2024). The definition of aphantasia as originally proposed, "reduced or absent *voluntary* imagery" (Zeman et al. 2015; our italics), was therefore correct.

The term aphantasia has been rapidly adopted since its inception, with an increasing number of publications attempting to examine this construct of visual imagery and its neurobiological correlates by means of various investigations.

2.2. Investigations

2.2.1 Surveys and Questionnaires

The work of Sir Francis Galton (Galton, 1880; 1883) on mental imagery is considered to have "pioneered the quantitative study of visual imagery" (Zeman et al., 2015) and to be "seminal" in the field (Pearson, 2019). Galton circulated some "Questions on visualising and other allied faculties" which aimed to "elicit the degree in which different persons possess the power of seeing images in their mind's eye, and of reviving past sensations". He recommended that readers "think of some definite object – suppose it is your breakfast table as you sat down to it this morning", hence the subsequent designation of these questions as the "breakfast-table survey". Galton listed 14 different aspects to be considered, including the illumination, definition, colouring, extent of field of view, distance, and command over the images that arose before the mind's eye. In point number 12, respondents were asked to call up specified objects and to "consider carefully whether your mental representations of them generally, is … very faint, faint, fair, good, or vivid and comparable to the actual sensation". Galton reported that from "inquiries I have already made, it appears that remarkable variations exist both in the strength and in the quality of these faculties" (Galton, 1883:378).

Galton's "breakfast-table survey" has served as the basis for subsequent questionnaires designed to examine visual mental imagery (Table 1) (Betts, 1909; Marks, 1973; Zeman et al., 2015), including the Vividness of Visual Imagery Questionnaire (VVIQ), although unacknowledged by Marks (1973). VVIQ in its original and modified forms has become ubiquitous in the assessment of phantasia and is considered the "gold standard used to measure visual imagery" (Pearson, 2019). VVIQ comprises a series of 16 questions requiring participants to visualize four aspects of four different prompts (specifically: some relative or friend whom you frequently see but who is not with you at present; a rising sun; the front of a shop which you often go to; a country scene) using a five-point Likert rating scale (Table 1) dependent upon comparison with "normal vision" (Marks, 1973) or "real seeing" (Zeman et al., 2015).

Table 1: Mental imagery questionnaires: scoring

(Betts, 1909)	**VVIQ (Marks, 1973)**	**Modified VVIQ (Zeman et al., 2015)**
-	16 questions, 4 aspects of 4 prompts	16 questions, 4 aspects of 4 prompts
1 perfectly clear and as vivid as the actual experience 2 very clear and comparable in vividness to the actual experience 3 moderately clear and vivid 4 not clear or vivid, but recognisable 5 vague and dim 6 so vague and dim as to be hardly discernible 7 no image present at all	1 Perfectly clear and as vivid as normal vision 2 Clear and reasonably vivid 3 Moderately clear and vivid 4 Vague and dim 5 No image at all, you only "know" that you are thinking of the object	5 Perfectly clear and lively as real seeing 4 Clear and lively 3 Moderately clear and lively 2 Dim and vague; flat 1 No image at all, you only "know" that you are thinking of the object
-	Score range 16-80, lower scores denote more vivid imagery	Score range 16-80, higher scores denote more vivid imagery

Although, as pointed out by Blomkvist and Marks (2023), VVIQ was not designed to be a diagnostic test, modified VVIQ scores have been used to categorise individuals in various ways. Zeman et al. (2015) defined a "no imagery" group (VVIQ = 16; i.e. at floor) and a "minimal imagery" group (VVIQ = 17-30). In this study, the highest VVIQ score achieved by individuals self-identified with aphantasia was 32, so a "weak or limited visual imagery" group with VVIQ scores 17-32 has also been used in some studies (Zeman et al., 2020; Keogh and Pearson, 2024). Modified VVIQ scores have been used to categorise individuals as having aphantasia (16-23/80), hyperphantasia (75-80/80), and "midrange imagery vividness" (55-60/80) (Milton et al., 2021).

Following Farah's (1984) distinction, the VVIQ prompts to recall familiar faces (e.g. "some relative or friend whom you frequently see") or objects (e.g. "the front of a shop to which you often go") may be construed as tests of visual memory, whereas instruction to imagine scenes or places (e.g. "a rising sun" or "a country scene which involves trees, mountains and a lake") are exercises in image generation. Hence these latter prompts may examine cogitative powers with or without the exercise of cognitive (mnemonic) functions.

Surveys and questionnaires other than VVIQ are available for assessing mental imagery (Pearson et al., 2013), but none has achieved the ubiquity of VVIQ.

2.2.2 Neuroimaging

Assessment of visual mental imagery using questionnaires is entirely dependent on subjective report. It has been suggested that brain imaging techniques, specifically functional magnetic resonance imaging (fMRI), can investigate imagery content objectively (Pearson, 2019). fMRI is considered to give insights into localization of brain functions. As such, it has been applied in experimental studies of individuals diagnosed with aphantasia and hyperphantasia by self-report and/or VVIQ scores. There is also substantial literature on fMRI in neurotypical subjects during mental imagery tasks, both sensory and motor.

A widespread network in frontal and posterior brain regions was activated on fMRI when a patient (MX) with acquired loss of visual imagery attempted mental imagery of faces which had previously been shown, findings similar to those in control subjects but with decreased activation in a posterior network of regions (bilateral fusiform gyri, superior temporal gyri and sulci, inferior occipital gyri, calcarine sulci) and greater activation in predominantly anterior regions (right anterior cingulate, bilateral inferior frontal gyri, precuneus). The latter finding was interpreted as an attempt to perform the task in a non-visual way (Zeman et al., 2010).

Using structural MR imaging, Thorudottir et al. (2020) suggested that a small area located in the left posterior medial fusiform gyrus was selectively damaged in a patient with acquired aphantasia, compared to other patients with bilateral and unilateral posterior circulation strokes but who had preserved mental visual imagery, and hence might be the cerebral correlate of visual imagery.

Considering developmental variations in phantasia capacity, Fulford et al. (2018) undertook fMRI studies in subjects (healthy undergraduates) selected for high and low vividness defined by VVIQ scores. Using whole brain analysis and static tasks (visualisation of an image or scene without rotation of images) to investigate correlates of imagery vividness, they found both positive (fusiform gyrus, posterior cingulate and parahippocampal gyri) and negative (anterior cingulate, auditory, insular, and early visual cortices) correlations in the low vividness group. These results were held to be broadly consistent with those found in the patient (MX) with acquired loss of visual imagery (Zeman et al., 2010). These activations were suggested to reflect activity in regions with potential to drive the imagery process (positive correlations) and/or failure to suppress activity (negative correlations).

Resting state and active task-based fMRI paradigms were examined by Milton et al. (2021) in individuals with aphantasia, hyperphantasia, and "midrange imagery vividness", these categories defined by modified VVIQ scores (respectively 16-23/80; 75-80/80; and 55-60/80) although the aphantasia and hyperphantasia subjects reported their imagery vividness had been a lifelong trait. Those with "midrange imagery vividness" constituted the control group. The findings were of stronger connectivity between prefrontal cortices and the visual-occipital network in hyperphantasic compared to aphantasic subjects in resting state fMRI. It was suggested that this observation underpinned aphantasics' impairments in voluntary imagery generation, with phantasia interpreted as "vision in reverse". In task-based fMRI (attempted visualisation of previously seen and recognised famous faces or places; modified version of protocol performed by patient MX in Zeman et al., 2010), no difference was found between groups in visualisation vividness for famous face or place tasks, and no differences when comparing perception and visualisation with the control condition. However, hyperphantasic and control patients showed greater anterior parietal activation compared to aphantasic subjects when comparing visualisation of famous faces and places with perception. This was interpreted as weaker deployment of visual attention during attempted visual imagery in the aphantasics (Milton et al., 2021).

In neurotypical subjects attempting visual mental imagery tasks, initial studies reported selective activation of cortical regions specialised for perception of faces or places respectively according to task, suggesting common processing mechanisms for imagery and perception (O'Craven and Kanwisher, 2000) although with different network dynamics (Lee et al., 2012; Dijkstra et al., 2018). However, meta-analyses of fMRI studies (Spagna et al., 2021, 2024) have shown no evidence for imagery-related activity in early visual cortices, whereas fronto-parietal networks and a region of the left fusiform gyrus, a high-level visual region, were engaged.

3. Conceptual considerations

3.1 Terminology

The "language-game of inventing a name for something" as described by Ludwig Wittgenstein (*Philosophical Investigations* §27) is familiar enough in neurology and neuroscience but does not necessarily imply a new discovery. Names other than aphantasia have been used for the loss or diminution of visual imagery, including "blind imagination" (Zeman et al., 2010), "blind mind" (Keogh and Pearson, 2018), and "imagery weakness" (Dance et al., 2022). Terms such as "visual irreminiscence" (Nielsen, 1946), "loss of visualization" (Brain, 1954), and "defective revisualization" (Botez et al., 1985) used previously may have been describing the same phenomenon.

New clinical neurological and neuroscientific discoveries (or rediscoveries) may pose new conceptual problems, distinct from empirical questions, and thus requiring conceptual analysis. Deriving from the analytic philosophy developed by, amongst others, Ludwig Wittgenstein (1889-1951), Bennett and Hacker (2022) have used connective conceptual analysis, to examine systematically a range of issues pertinent to clinical and experimental neuroscience. Such analysis has also been applied to studies of consciousness and voluntary action (Nachev and Hacker, 2010; 2014), and it has been suggested that this form of analysis may be one of Wittgenstein's most enduring and necessary legacies to neurology and neuroscience (Larner, 2022).

By definition, a neologism is a newly coined word or expression and thus has no previous usage. This might prove a stumbling block to any attempt at connective conceptual analysis of phantasia. However, the terminology stems ultimately from Aristotle (385-322 BCE), the term "aphantasia" being proposed on the basis of Aristotle's use of phantasia (φαντασία) to describe imagination, the "faculty/power by which a phantasma is presented to us", where phantasma is rendered as "image or mental representation" (Zeman et al., 2015). Amongst the functions allocated by Aristotle to the *sensus communis*, one was image formation by the imagination, or fantasia. This function presupposed antecedent perception but did not require current use of a perceptual organ. Aristotelian explanations of cognitive functions persisted for more than two millennia. For example, in *The Anatomy of Melancholy*, dating from the early to mid-seventeenth century, Robert Burton (1577-1640) stated that "The Apprehensive faculty is subdivided into two parts, Inward, or Outward. Outward, as the five senses, … Inward are three; Common Sense, Fantasy, Memory". Furthermore, "Fantasy, or Imagination … is an inner sense which doth more fully examine the species perceived by Common Sense, of things present or absent, and keeps them longer, recalling them to mind again; or making new of his own. In time of sleep this faculty is free, and many times conceives strange, stupend, absurd shapes, as in sick men we commonly observe" (Gowland, 2021).

Bennett and Hacker (2022) used the term fantasia to denote the capacity to conjure up images, a cogitative power distinct from the creative faculty of the imagination, since mental images are neither necessary nor sufficient for the exercise of the powers of the imagination. The cogitative faculty of imagination encompasses an extensive conceptual network of which imagery forms only one part. Thus "one may have a rich and fertile creative imagination without having much ability to conjure up images. There seems little *logical* connection between the two powers" (italics in original). Hence fantasia or phantasia (henceforward we use the latter, following Zeman, with the exception of direct quotations, as more appropriate to the original ancient Greek term) may be used to denote the capacity or faculty to conjure up mental images of either previously experienced or novel scenes. As such, "one can make discoveries about people and their faculty of fantasia" (Bennett and Hacker, 2022). But how is this capacity to be understood conceptually?

3.2. Conceptual analysis

Mental imagery has been a subject of inquiry for philosophers for millennia. This interest has principally focused on visual imagery or visualisation. Indeed, some have questioned whether or not mental imagery can occur in other domains: "we can visualise even with our eyes closed (OED: 'visualise: to construct a visual image in the mind') but nobody has ever been known to *audibilise*, *gustatise*, *olfactorise* or *tactualise*" (Bamforth, 2015; italics in original). However, mental imagery may occur in other domains (auditory, olfactory, gustatory, haptic), and its absence or loss be noted: the absence of auditory imagery has been termed anauralia (Hinwar and Lambert, 2021). Aphantasia may possibly be one subtype of a broader imagery deficit, termed dysikonesia by Dance et al. (2021b), which may include subjective lack of auditory and olfactory imagery (Dawes et al., 2024). The focus here will be confined to visual mental imagery.

In their conceptual analysis of imagination and mental images, Bennett and Hacker (2022) noted that "Mental images … are a major source of conceptual confusion" but they did not specifically address aphantasia and hyperphantasia (the characterisation of these constructs post-dated their original work). At the heart of this conceptual confusion lies the supposition that mental images are just like physical images, but mental; the use of the term "the mind's eye" (e.g. by Galton and by Sacks) presupposes this equivalence. However, there are many differences between visual perception and visual mental imagery. For example, the independence of the objects of perception, perceptibilia, contrasts with the dependence of mental images on the exercise of the faculty of phantasia. The latter capacity, unlike perception, has no sense organs: the brain is not an organ of imagination, and one does not "see" mental images, contrary to the notion of "the mind's eye". Hence unlike perception, phantasia does not operate under conditions which may be optimal or suboptimal, hence mental images cannot be improved by changing the viewing conditions or looking closer. Mental images are therefore not subject to error in the way that perceptions may be correct or incorrect, mistaken, or overlook certain features. They cannot be mistaken for hallucinations or after-images, and are not located in physical space. Mental images are not perceptible, are not private visibilia, and since they have no non-representational properties are not representations. The notion of a representation implies both representational content and a non-representational medium. For example, the medium of a portrait sketch may be pencil on paper or oil on canvas. A mental image may be represented by the subject's sketch, verbal description, manual gestures, etc, but without a medium it can be no more of a representation than the object of (say) a photograph is itself a representation. It may be argued that the subject "as whole" constitutes a multimedia representation of the world he or she has been exposed to, but the representation is then in the expression, and its chosen medium on a specific occasion. In sum, visual perceptions and visual mental images "do not coexist in the same *logical* space" (Bennett and Hacker, 2022; italics in original).

Mental imagery is not susceptible to ostensive definition. There is no public sample, nothing that can be pointed to, or to which reference can be made, for the purposes of definition. A mental image is not dissociable from its reported experience, for it is only *through* its reported experience that it can be communicated. Since we do not see (or hear, or taste, or smell, or feel) images in the brain or in the mind's eye (or the mind's ear, mouth, nose, or skin), it makes no sense to characterise these as experiences as "faint" or "vivid", although an individual may be able to give a lively and vivid description of their mental experience. It is not merely that the deficit of the aphantasic may lie anywhere between the supposed mental image and its report, it makes no sense to speak of an independent mental image at all, for the criteria of the concept of an image - independent observability through the organs of perception - are not satisfied. We could, of course, engineer a new concept that reflects the constitutional inseparability of image and report, but not without considering what aspects, if any, of a physical image we can licitly extend to it. Lexical identity does not confer semantic identity.

Thus it is a conceptual error to state, as Sacks (2010) does, that he has "visual images … that allow visual perception" since one does not "see" visual mental images in the way that one sees the objects of visual perception. Whilst Rademakers and Pearson (2012) rightly acknowledge that "it is not possible to be 'correct' or 'incorrect' about an internally generated image", unlike the case with visual perception, nevertheless they assess visual imagery with a scale which at its maximum rates "strong imagery" to be "*almost like perception*" (italics in original). We cannot calibrate mental imagery to perception because there is no mechanism - logically, not practically - for comparing a physical and a mental image: all we have is the reported experience. Indeed, an avowed aphantasic might experience imagery far more vividly than any normal person and differ instead in his interpretation of what vividness means in the context of mental imaging. This sounds perverse only because we are still so easily deceived into conflating the physical and the mental, nearly a hundred years after Wittgenstein warned us of the danger.

This conceptual confusion is both long-standing and linguistically ingrained. The idea that visual mental imagery might be simply "a fainter form of perception" dates at least to David Hume (1711-1776) in *A Treatise on Human Nature* (1739). The terminology used to characterise phantasia presupposes the process(es) underlying this faculty to be akin to those in perception, e.g. visual imagery, visualisation, and phantom vision (Keogh and Pearson, 2021). Likewise, the terminology characterising aphantasia: “blind imagination” (Zeman et al., 2010), and “blind mind” (Keogh and Pearson, 2018, 2024). Hence it is but a short step to characterise visual mental imagery as “vision in reverse” or “like a weak form of perception” perhaps due to selective involvement of the ventral visual “what” pathway with sparing of the dorsal “where” pathway (Pearson, 2019).

These conceptual considerations should inform empirical studies of aphantasia. For example, whether or not the neural systems involved in the exercise of phantasia correspond in some ways to those involved in visual perception, as might be suggested by the principle of parsimony, remains a legitimate question for empirical investigation, but only once we have clarity on the underlying conceptual terrain.

4. Empirical data revisited in the light of conceptual considerations

4.1 Clinical diagnosis

The diagnosis of aphantasia is based on the sincere avowal of an individual who reports an absence of the power, capacity or faculty of visual imagery, be it lifelong (congenital, developmental) or acquired.

This form of behavioural criterial (non-inductive) definition is familiar to neurologists since it is in the nature of much neurological practice to rely exclusively on subject history (or anamnesis) for the purpose of diagnosis, without recourse to specific investigations to confirm or refute the suspected diagnosis (i.e. inductive correlations). This is the idiom of clinical diagnosis in, for example, headache disorders, and sensory syndromes including pain, and many cognitive and psychiatric disorders.

As already described (Section 2.1), much has been learned about aphantasia using this criterial approach. For example, it is evident that phantasia is not a uniform faculty or capacity: it may be voluntary or involuntary, and these capacities may be dissociated in aphantasics; its absence may be a congenital or developmental phenomenon or may be acquired as a result of brain injury; there may be associated selective visual perceptual deficits (e.g. prosopagnosia) or there may be dissociation of imagery and perceptual deficits .

Behavioural criteria may be defeasible, but only in the unlikely event of the avowal being insincere, i.e. an avowal of the experience of imagery despite its absence in an aphantasic, a false positive; or an avowal of the absence of imagery despite its presence, a false negative. The behavioural criterion of sincere avowal is a warrant to believe that mental imagery is present or absent, as avowed, and there is no sense to speak of the sensitivity or specificity of this form of behaviour.

4.2. Investigations

The investigation of aphantasia seeks inductive correlations with the behavioural, criterial definition. This form of inductive correlation is familiar to neurologists since it is in the nature of much neurological practice to seek confirmation or refutation of clinical (behavioural criterial) diagnosis by means of investigations seeking established clinico-anatomical or clinico-radiological correlations.

The inductive, clinico-radiological, correlation of aphantasia with focal structural neuroimaging changes reported by Thorudottir et al. (2020) was not instrumental in making the diagnosis of aphantasia, which was based on the non-inductive criterion of the patient’s report. Whilst such correlations may help to establish a cause for aphantasia (e.g. stroke) they give no insights into the workings of the faculty of phantasia. Other investigations (surveys and questionnaires, functional neuroimaging) have been suggested to give such insights, but these all highlight the inherent difficulties in measuring mental imagery.

4.2.1 Surveys and Questionnaires

Many conceptual confusions are apparent in Galton's "breakfast-table survey" which may have consequences for hypotheses underlying neuroscientific research.

For example, Galton's point 1 asked of the mental image "Is its brightness comparable to that of the actual scene?" But, as conceptual analysis shows, mental images, not being perceptions, cannot be said to be more or less vivid than what they are images of, and they are not dependent on observation conditions. Galton's point 4 asks "Can you mentally see more than three faces of a die, or more than one hemisphere of a globe at the same instant of time?" But mental images are not seen with the mind's eye, since to have visual imagery is not to see at all but visually to imagine or recollect. Galton's point 5 asks "Where do mental images appear to be situated? within the head, within the eye-ball, just in front of the eyes, or at a distance corresponding to reality?" But since a mental image cannot appear or seem to be located anywhere, this makes no sense. Galton's point 7, in asking the respondent "Can you deliberately seat the image of a well-known person in a chair and see it with enough distinctness to enable you to sketch it", supposes mental images to be private visibilia. But one cannot "see" one's mental images, although one can draw what one imagines visually. The same point asks "Can you at will cause your mental image … to … turn slowly round?", which is misleading since although one can imagine an object rotating one cannot turn one's mental image of an object around. Galton's point 9 asks "Have you ever mistaken a mental image for a reality when in health and wide awake?", but this is misguided since there is no such thing as mistaking a mental image for reality since they do not coexist in the same logical space.

As Galton's "breakfast-table survey" served as the basis for the development of VVIQ, it is not surprising that there are a number of conceptual issues related to the use of VVIQ, either in its original (Marks, 1973) or modified forms (Zeman et al., 2015).

The Likert scaling of the VVIQ is dependent upon comparison with "normal vision" (Marks, 1973) or "real seeing" (Zeman et al., 2015). Hence phantasia is equated here with perception, but, as we have seen, there is a logical difference between perceiving an object and having an image of that object, a conceptual confusion inherent in point 1 of Galton's questionnaire. Since mental imagery is not susceptible to ostensive definition, the issue is in fact one of validation: there is no way to show that this scale measures what it purports to measure. There is no possibility of assessing intersubjective agreement, other than the simple binary of subject report of the absence or presence of a mental image. The intermediate gradations are entirely subjective.

Furthermore, since mental images are not seen, because they are not percepts, it makes no sense to try to categorise them, as for percepts, along a faint-to-vivid continuum. This mistake perhaps has its origin in Hughlings Jackson's use of the faint/vivid dichotomy to differentiate ideation and perception, e.g.:

> When we actually see and *recognise* external objects, we have *vivid* visual ideas. There is then strong excitation of the retina, thence to the highest centres in the

> cerebrum, and back to the ocular muscles… When we have faint visual ideas, (Think of objects when they are absent – "recollect" them, &c.) there is slight or nascent excitation (discharge) of higher centres … (Jackson, 1874; italics in original).

Furthermore, if it is indeed the case that "Imagery vividness changes from moment to moment" (Pearson, 2019) it is difficult to understand how any meaningful scaling could be made. Imagery performance may be susceptible to factors such as time of day (Gueugneau et al., 2009) and physical or mental fatigue (Di Rienzo et al., 2012). Moreover, trial-by-trial vividness ratings are unrelated to VVIQ scores (D'Angiulli et al., 2013). These observations may perhaps explain Galton's observation "that remarkable variations exist both in the strength and in the quality of these faculties".

Although these conceptual issues may seem academic, there are consequences for neuroscientific understanding, as reflected in anomalies found when using the VVIQ in practice. For example, discordance between subjective patient report of visual imagery (improving) and VVIQ score (static) has been reported in a patient with acquired aphantasia (Bumgardner et al., 2021). More concerning is the mismatch in performance on VVIQ and other tasks used to assess aspects of imagery, for which many scales are available besides VVIQ (Pearson et al., 2013). For example, the patient "MX" (Zeman et al., 2010) was at floor on the modified VVIQ (16/80) but passed several other tests addressing the construct of mental imagery, such as the Mannikin (or stickman) tasks (requiring "mental rotation" in space; Ratcliff, 1979), letter form tests (requiring judgments about whether letters have curved parts; van der Meulen et al., 2009), and the animals' tails test (requiring judgments about a named animal's tail length relative to body size; Behrmann et al., 1994). The study by Milton et al. (2021) found no differences between aphantasics, controls, and hyperphantasics (groups defined on the basis of VVIQ scores) in these other tests of visual imagery, findings explained on the grounds that the Mannikin and letter form tests assess spatial imagery rather than object imagery. They suggested that the animals' tails test, which does address object imagery (Farah et al., 1988), may have been completed by their subjects on the basis of knowledge rather than imagery. The lack of agreement between these different instruments, indicating a lack of convergent validity, suggests that they are not measuring a uniform construct: object imagery and spatial imagery may be distinct (Bainbridge et al., 2021). Keogh and Pearson (2018) found preserved spatial imagery in aphantasics despite poor object imagery when using the dedicated subscales of the Object and Spatial Imagery Questionnaire (OSIQ), a self-reported questionnaire measure used to assess individual differences in object and spatial imagery (Blajenkova et al., 2006; Vannucci et al., 2006), the two scales of which are reported to predict performance on object imagery and spatial imagery tasks (Blazhenkova and Kozhevnikov, 2010).

It may also be noted that all the prompts in VVIQ relate to voluntary imagery; none address involuntary imagery, as in dreams or reveries. Were the latter to be included in a questionnaire, as per the documented experience of aphantasics (e.g. Sacks, 2010; Zeman et al., 2015, 2020) then different scores would be obtained, and hence the division into aphantasia, hyperphantasia, and "midrange imagery vividness" might be quite different.

4.2.2 Neuroimaging

Based on the findings in a study of resting state and active task-based fMRI in individuals with aphantasia, hyperphantasia, and "midrange imagery vividness", it has been suggested that the "neural signatures of visual imagery vividness extremes validate … this … neglected dimension of individual difference" (Milton et al., 2021). However, this is questionable.

When using a “midrange imagery vividness” group as controls, inductive correlations between VVIQ and fMRI were made in the absence of criterial (behavioural) definition, as was also the case in the fMRI study of developmental variations in phantasia capacity (Fulford et al., 2018). No data supporting the choice of VVIQ cut-offs were presented (nor, in light of the conceptual analysis, could they be).

The suggestion that fMRI is an entirely objective way to investigate voluntary mental imagery is questionable, at least with the paradigms used hitherto. If fMRI elicits a particular pattern of neural activity when a participant attempts to imagine a scene, the absence of the same activity in aphantasics attempting the same task does not imply the absence of the corresponding mental capacity: to believe otherwise is to commit the logical fallacy of affirming the consequent. Furthermore, a voluntary activity such as imagining implies a capacity for choice. If a participant cannot choose to obey or disobey the command to imagine, because s/he believes her/himself incapable of it, no distinction can be made between failing to attempt the task and failing to execute it. In any event, single subject activations are too variable to permit generalisation across a population. Similarities and differences in activation patterns across groups may be explained by any aspect of the observed behaviour, including its report. Any overlap between areas activated by perception and mental imagery do not imply a shared critical substrate, for – as the affordance literature shows – activation necessarily extends beyond the actual task performed to the tasks that *could* in the circumstances be performed. That the constraint on the space of possibility is difficult here does not mean that it can be simply ignored.

5. Discussion and future directions

Considerations concerning the nature of mental imagery are long-standing, at one time spawning “the imagery debate” about the nature of visual “mental representations”: symbolic/propositional vs. pictorial/depictive (Pylyshyn, 1973; Kosslyn, 1980), a debate now declared ended on the basis of empirical findings (Pearson and Kosslyn, 2015). The crux of the debate is the representational *form* - symbolic vs pictorial - of what are assumed to be “mental objects”. But imagining an image is not the perception of a “mental object” and can have no representational form because no distinction between form and content is possible here. A subject’s *expression* of his or her mental imagery has form - drawn, painted, verbally related, etc. - but that is a matter of the subject’s choice of expression, and will vary with it. It is legitimate to ask how the capacity for imagery may be neurally - not mentally - *encoded*, but neural codes are neither symbolic nor pictorial, for these descriptors lack meaning in the context of neural substrates, real or artificial. Kosslyn and his colleagues argue that the activation of retinotopically organised visual areas during imagery provides incontrovertible proof of the existence of pictorial (necessarily neural, not mental) representations. This argument seems to us both empirically and conceptually far from conclusive. Empirically, since correlative evidence does not imply causation, disruptive evidence of normal imagery in patients with visual cortex lesions (e.g. Chatterjee and Southwood, 1995) discounts it. Furthermore, just as affordance-related activation of neural substrates underpinning counterfactual actions that are *not* executed may accompany their possibility (Gibson, 1977), so activation of visual substrates may incidentally accompany imagery without perception. Indeed, it would be profoundly surprising if it did not, given the similarities between imagery and aspect perception (cf. ambiguous figures). Conceptually, since imagery extends beyond experienced reality to imagined counterfactual possibility, it is mathematically impossible to encode it in retinotopic space. Even if we were to rasterize the retinal image at an implausibly coarse 512x512 resolution, and assume only 256 colours, the number of possible visual element combinations is infeasibly large at 256^{512^2}. This is why *all* generative models of images with anything approaching human expressivity incorporate an explicit or implicit information bottleneck in their architectures (Tishby and Zaslavsky, 2015), relying on latent representations far more compressed than native, geometric space. However visual information is encoded, it is hard to see how it could be in any kind of simple, pictorial space.

Whilst it might be argued that to speak of "mental images" or "visual imagery" is simply to use the tools of metaphor and analogy (Churchland, 2005), it has been previously noted that "the picture metaphor … is seriously misleading, especially as it suggests that the image is an entity to be perceived" (Pylyshyn, 1973; see also Bennett and Hacker, 2022). The problem with analogical use is that researchers often forget to observe the limits of the analogy and transfer properties of the source that do not apply to the target.

Neuroscientific research often seeks to link conceptually heterogeneous domains: the behavioural with the "inner", namely the psychological and the neural (Bennett and Hacker, 2022). Milton et al. (2021) correctly identified the "need to triangulate … first-person findings with more objective measurements of both behavioral and neural correlates of visual imagery extremes" (we would substitute "psychological" for "behavioral" here, taking the patient avowal to be the behavioural, criterial definition, and the measurements assessing visual imagery as the "psychological" and "neural"). Is it possible to offer a conceptual framework for future empirical studies, circumventing the conceptual confusions that have been outlined?

Because surveys and questionnaires addressing mental imagery are necessarily reliant on self-report they cannot be validated, as such subjective reports are not susceptible to ostensive definition; there is no public sample, standard or paradigm to which reference can be made for comparison. Accordingly, selecting participants for studies of aphantasia/hyperphantasia on the basis of VVIQ scores, or other subjective surveys and questionnaires, risks the introduction of conceptual error at the outset which might impact conclusions derived from empirical findings. This may be avoided by initial selection on the basis of sincere avowal (i.e. behavioural criterion). The ongoing need for "a specialised aphantasia measure", distinguishing sensory and spatial imagery, and assessing metacognition and memory, has been urged (Blomkvist and Marks, 2023). This might be addressed by use of behavioural techniques such as binocular rivalry dominance (Pearson, 2014; Keogh and Pearson, 2018) or neurophysiological measures such as imagery pupillary light response (Kay et al., 2022) and corticospinal excitability during motor simulations (Dupont et al., 2024) might obviate the need for self-report questionnaires. Aphantasics as a group showed a binocular rivalry priming score which was not significantly different from chance (Keogh and Pearson, 2018, 2021, 2024), no significant evidence of an imagery pupillary light response (Kay et al., 2022), and deficit in activating the motor system during motor simulations (Dupont et al., 2024).

The critical question is whether there is any plausible mechanism for dissociating a visual recollection from its report, and from the space of possible behaviours the experimental context will tend to activate. Such dissociation requires the behavioural task to run *counter* to whatever process imagery supposedly invokes, involving paradigms very different from those hitherto investigated. One possibility is to probe the retrieval of a verbally describable aspect of an image - for example, the class to which the object belongs - in a context where involuntary retrieval of another aspect interferes with it, an approach theoretically realisable with ambiguous figures. The perception of multiple rival aspects of an image, such as the Wittgenstein rabbit-duck figure, involves a visual imaginative process - "seeing as" - even if it is grounded in direct visual experience. The aphantasic would be predicted to be “less” susceptible to interference in retrieving one aspect owing to difficulty in perceiving its rival.

Adoption of these approaches may permit clearer inferences to be made with respect to mental imagery capacity and its possible relation to perceptual capacities.

6. Conclusion

As in other fields of neuroscientific research, conceptual confusions may hinder progress in the understanding of phantasia. Specifically, there remains confusion regarding the independence of the objects of perception and the dependence of mental images on the exercise of the faculty of phantasia. Because mental imagery is not susceptible to ostensive definition, subjective self-report questionnaires cannot be validated, there is no possibility of assessing intersubjective agreement, and categorisation of mental imagery along a faint-vivid continuum makes no sense. The inference that neural activity as measured by fMRI underlies the mental activity of imagery also is not validated.

Whilst it remains possible that neural systems involved in the exercise of phantasia overlap in some ways with those involved in visual perception, the neuroscientific understanding of phantasia based on empirical studies will be compromised if conceptual confusions are not first addressed.

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Highlights

- The human capacity of visual mental imagery, "phantasia", has recently been characterised as having extremes designated as "aphantasia" and "hyperphantasia".
- Mental imagery has long been noted as a source of conceptual confusions but no specific conceptual analysis of these new formulations of phantasia, aphantasia and hyperphantasia, has yet been presented.
- There is ongoing confusion of perceptual images with mental images: there is a logical difference between perceiving an object and having an image of that object.
- The Vividness of Visual Imagery Questionnaire (VVIQ), used ubiquitously in diagnosis and assessment of "aphantasia" and "hyperphantasia", is an unvalidated subjective assessment instrument.
- VVIQ or other subjective surveys cannot be validated, since they are not susceptible to ostensive definition, cannot be assessed for intersubjective agreement, and hence should not be used.
- Absence of a particular pattern of neural activity on fMRI when an aphantasic attempts to imagine a scene which produced that pattern of neural activity in a control subject attempting the same task does not imply the absence of the corresponding mental capacity: to believe otherwise is to commit the logical fallacy of affirming the consequent.
- The neuroscientific understanding of phantasia based on empirical studies will be compromised if conceptual confusions are not first addressed.