THE RELATIONSHIP BETWEEN APHANTASIA, DAYDREAMING, AND RUMINATION

by

JASMINE PACHECO

Submitted to the Psychology Department

School of Natural and Social Sciences

in partial fulfillment of the requirements

for the degree of Bachelor of Arts

Purchase College

State University of New York

Sponsor: Stephen Flusberg, Ph.D.

Second Reader: Alexia Toskos, Ph.D.

Abstract

The ability to see with one's mind's eye is a cognitive ability that many people possess. The vividness of this visual mental imagery varies from person to person. Visual imagery plays a role in multiple different cognitive domains such as spatial navigation, memory, language, daydreaming, rumination, and others. Some people do not have the ability to use visual imagery at all; this condition is known as congenital aphantasia. This condition is relatively new in the field of psychology and not much is known about why it occurs. There are some differences in cognition in individuals with aphantasia but the extent of these differences is not known. This paper reviews the existing literature on aphantasia and explores ideas for future research. Specifically, research to address gaps in the literature. Prior research has compared the extent of PTSD symptoms in individuals with and without aphantasia; future research would examine multiple different mental illnesses characterized by visual imagery. Prior research has also compared the frequency of daydreaming in individuals with and without aphantasia; future research would address the frequency and extent of different types of daydreams in these individuals.

Keywords: Aphantasia, visual imagery, rumination, daydreaming, creativity

The relationship between Aphantasia, Daydreaming and Rumination

Introduction

Visual imagery is a pervasive part of many people's lives. Most people have the ability to visualize objects in their minds to some extent. Common examples of visual imagery include the mental visualization that occurs when reading a book and the mental pictures summoned by remembering an event or daydreaming. For instance, imagine a red apple sitting on a table. Can you see the color of the apple in your mind's eye? Do you experience the exact shape of an apple or a vague silhouette? Can you imagine picking up that apple from the table and biting into it? Can you imagine the texture in your mouth? How about the taste? Now shift your mind's eye to imagine walking through a park with a friend. It is a sunny day with a few white clouds in the sky and the park is filled with tall oak trees. The park is filled with green grass and clovers and you walk past a small pond. In the pond are birds such as ducks and geese and on the other side of the pond there is a playground. There are children running around the playground playing on a bright yellow swing set and a steep blue slide. One child is wearing the same orange shirt as the friend you are walking with. You turn to tell them but you can already see the embarrassment on their face. Were you able to picture both scenarios entirely or only portions of each? Maybe you were not able to see anything at all. If you were able to muster some form of mental picture in your mind without any external stimuli, that is an example of visual imagery.

Both scenarios I mentioned require a different degree of mental imagery; from imagining a still apple sitting on a table to imagining the look of embarrassment on the face of a close friend. Not all people can imagine both scenarios to their full extent; some may only be able to imagine a red circle instead of an apple. Others can see a familiar face in their mind's eye with no difficulty. This is because, as past research has indicated, there are differences in how people

think, and individuals do not have a uniform way of processing information (Roebuck & Lupyan, 2020). For example, some people may have a more visual cognitive style while others may have a more verbal cognitive style. One phenomenon related to mental imagery that has been gaining attention is a condition known as congenital aphantasia. Congenital aphantasia is a condition characterized by a lack of visual imagery. Researchers have established that aphantasia is defined by the lack of the experience entirely and not by a lack of metacognition (Keogh & Pearson, 2018). Therefore, individuals with aphantasia are capable of recognizing their own thoughts and thought processes (Jacobs et al., 2017) but they lack the ability to experience the sensory qualities of objects that are not available to them.

Certain cognitive processes, like daydreaming, seem to require some amount of mental imagery. Daydreaming consists of a stream of subjective experiences where there is no specific stimulus, task, or response (Vaitl et al., 2005). Psychologists have hypothesized that daydreaming, mental imagery, and creativity are closely intertwined. Creative thoughts are formed through exploring novel ideas and "what if" questions, and these ideas are cultivated by spontaneous thought and mind wandering which are forms of daydreaming. (Zedelius & Schooler, 2016).

Rumination has also been linked to the use of mental imagery. Rumination is a form of preservative thought that focuses on past and present emotional distress (Sansone & Sansone, 2012). Rumination has been linked to depression and it is established that rumination worsens symptoms of depression (Hoeksema & Lyubomirsky 2008). Some studies have evaluated the presence of "visual thought" compared to the presence of "verbal thought" in association with rumination and depression. They found that depressive cognitive style significantly moderated the relationship between rumination and depressive symptom severity. There was a stronger

relationship for individuals who had a visual depressive cognitive style compared to a verbal depressive cognitive style (Lawrence et al., 2018).

The goal of this paper is to explore the link between aphantasia and other psychological phenomena such as daydreaming and rumination, as well as the possible associations between aphantasia, creativity, and depression. Are individuals with aphantasia less prone to daydreaming or rumination due to their lack of visual imagery? Does this difference in cognitive style have any impact on the experiences or personality of a person with aphantasia? Are individuals with aphantasia less prone to daydreaming, and would this mean that they are less creative? Does the same apply to aspects such as rumination and depression? Essentially, this paper will explore visual mental imagery and its connection to various parts of the human experience.

First, I will define and discuss visual imagery and the role it plays in cognitive domains such as spatial navigation, memory, language comprehension, morality, daydreaming, and rumination. This paper will also discuss the brain areas associated with visual mental imagery. This paper will focus on conscious forms of visual imagery. Then I will review literature on aphantasia and elaborate on the differences between the cognitive processes in individuals with aphantasia compared to those without. Lastly, this paper will include a discussion of current gaps in the research on aphantasia. I will conclude this paper with proposals for future research and the design for a potential research study to address current gaps in the literature.

Visual Imagery

Early philosophers believed that mental representation was essential to human cognition. The Greek word, “phantasma” was often used by Plato to refer to reflections in mirrors or pools. Aristotle, however, reserved the use of the word for appearances in the “psyche” or mind. Aristotle described phantasmata as being analogous to paintings but did not limit the use of

phantasma to inner pictures; rather, he believed that the concept played a role in perception itself (Thomas, 2021). Essentially, Aristotle believed that visual imagery was necessary for perception.

In the early 20th century, psychologists began to deny the existence of mental images. Psychologists that held a behaviorist view suggested that mental images are actually inner speech. Many psychologists supported this view until researchers began to study how mental images are used in learning, memory, and reasoning (Pearson & Kosslyn, 2015). For example, researchers showed that subjects are able to identify whether or not two different perspective drawings portray the same three-dimensional shape at different angles. This is possible because the visual mind is able to "mentally rotate" three dimensional objects (Shepard & Metzler, 1971). Other researchers looked at the ability for the mind's eye to "scan" visual images. In one study, participants looked at drawings and were later asked to verify structural features of those drawings from memory; the data suggested that participants were mentally scanning the images, as it took longer to verify a structural detail when subjects were previously focusing on a spatially distant part of the image (Kosslyn, 1973).

Though the data provides evidence for the ability to represent images mentally, there are some issues with this conclusion. For example, instead of using a mental image, some have suggested participants could have relied on more symbolic descriptions of the object in memory (Pearson & Kosslyn, 2015).

Recent literature has addressed this possibility that people can use internal description instead of mental images and introduced the notion that people use a combination of different formats when it comes to inner thought (Roebuck & Lupyan, 2019). In order to measure cognitive style researchers created the Internal Representation 12 Questionnaire (IRQ) which was designed to measure modes of thinking using four facets: Internal Verbalization, Visual

Imagery, Orthographic Imagery, and Representational Manipulation. Internal verbalization refers to one's "inner voice." Internal verbalization comes from the idea that human cognition is augmented by language. Visual imagery has been measured in the past to determine the extent of visual imagery an individual experiences. For example, a survey study from 1880 asked multiple men about their ability to imagine different everyday objects and answers ranged from picturing the actual scene in all its detail to picturing nothing at all (Galton, 1880). Orthography refers to written language, specifically, the relationship between phonemes and graphemes in a language. Finally, representational manipulation refers to the ability to manipulate internal representation. An example of representational manipulation would include comparisons of perceived objects. Essentially, prior research (Roebuck & Lupyan, 2019) showed that people vary on the extent to which they report using each of these modes of inner thought, and they are somewhat dissociable.

Psychologists and neuroscientists have made considerable progress in showing that visual imagery can be measured objectively and reliably, and indeed can be depictive in nature (Pearson & Kosslyn, 2015). There have been multiple research studies examining the physiological evidence for the presence of visual imagery. It was during the 1990's when neuroimaging became widely available to researchers (Pearson & Kosslyn, 2015). Looking at the cortical regions of the brain, researchers focused mainly on brain areas associated with visual perception. Researchers studied the primary visual cortex, V1, and were able to establish that there is depictive evidence of visual imagery (Albers et al., 2013). Essentially, researchers found that activity patterns in visual areas (V1–V3) could reliably predict which of three oriented gratings was either held in working memory or mentally imagined (Albers et al., 2013). The evidence from recent neuroimaging goes further. Researchers have been able to "decode" a mental image

from patterns of activation in area V1 solely based on brain activity (Kosslyn & Thompson, 1997). Therefore, researchers can learn what an individual is visualizing. Essentially, there is overlapping activity in the visual areas of the brain during visual perception and visual imagery.

There have been multiple studies examining the brain areas associated with visual imagery. Through these case studies and imaging studies, researchers have been able to create an idea of what brain areas assist in visual mental imagery. It is a common belief that there is significant similarity between seeing with one's eyes and seeing with the mind's eye. Essentially, researchers suggest that the neural machinery responsible for visual perception is also responsible for visual imagery (Kosslyn & Thompson, 1997). In one study researchers followed the assumption that cognitive processes such as visual imagery and visual perception share common representations; therefore researchers predicted an overlap in the neural activity that accompanies visual imagery and visual perception. Positron emission tomography (PET) was used to measure cerebral blood flow in participants while they completed tasks. In one condition participants had to decide whether names were appropriate for objects presented in canonical or non-canonical perspectives. In the canonical condition the objects would be recognized upon seeing it and in the non-canonical condition the objects were not recognized right away. The imagery task required participants to visualize upper case letters in grids and decide whether an X would have fallen on each letter, if it were actually present (Kosslyn & Thompson, 1997). Fourteen areas were activated in common by both tasks. Two locations were activated in perception but not imagery, and Five brain areas were activated in imagery but not perception. Therefore, there are shared brain areas for visual imagery and visual perception (Kosslyn & Thompson, 1997).

One issue that remains controversial is the role of V1 in visual mental imagery. To what extent is V1 required for visual mental imagery? Activation of V1 is only found in some mental imagery experiments, with other studies reporting no activation of V1 (Bridge et al., 2011). One study examined the pattern of cortical activation to visual mental imagery in the specific binding ratio (SBR). The results of this study suggest that visual mental imagery can be evoked strongly and successfully even when V1 is compromised. V1 is therefore not necessary for this type of mental imagery (Bridge et al., 2011).

Researchers have also created a way to measure visual imagery in individuals using a basic self report survey. The Vividness of Visual Imagery Questionnaire (VVIQ) is a tool often used in research to measure the extent of visual imagery an individual experiences (Marks, 1973). The VVIQ consists of 16 items in four groups of four items in which the participant is invited to consider the image formed in thinking about specific scenes and situations such as a natural scene like clouds or a storm. The vividness of the image is rated along a 5-point scale. The questionnaire has been widely used in multiple research studies to determine vividness of visual imagery that an individual experiences.

Why did humans develop this ability to see with their mind's eye? Researchers have suggested that mental imagery serves as a tool for human cognitive functions such as remembering events, navigating, and planning for the future (Winawer et al., 2010). For example, in a visual image vividness test participants were tested using colored photographs; they were shown images and later asked to recall features of the photographs. The results of this recall task indicated that those who reported more vivid visual imagery had more accurate recall of the photos (Marks 1973). This research suggests a link between visual imagery and visual working memory; visual imagery serves as a tool for working memory.

Visual imagery has been shown to be closely related to many cognitive functions such as visual memory (Albers et al., 2013, Keogh & Pearson, 2011, Keogh & Pearson, 2014), spatial navigation (Ghaem et al., 1997), language comprehension (Bergen et al., 2007, Zwaan et al., 2002), and making moral decisions or a decision to help others (Amit and Greene, 2012, Gaesser and Schacter, 2014). These findings help address the evolutionary origins of mental imagery by highlighting how imagery may be adaptive (Bechtel, 2003). In the following sections I will explore the link between visual imagery and these other cognitive domains.

Visual Imagery and Other Cognitive Domains

1) Spatial Navigation

Spatial navigation is an evolutionary adaptation that relates to the need to navigate when hunting or voyage over a large area. Traditional frameworks regarding multimodal processing and spatial navigation suggest the presence of a cognitive map when first learning to navigate an area. The cognitive map hypothesis proposes that the brain creates a rendering of the spatial environment to support memory and aid in navigating an environment (Epstein et al., 2017). Researchers also believe that the basic principles of the cognitive map, spatial coding, landmark anchoring, and route planning, can also be linked to many core elements of human thought. Moreover, cognitive maps can be applied to multiple different cognitive domains (Epstein et al., 2017). Cognitive map is a representation of one's environment and it could be used for real life problem solving tasks such as picking out clothes to wear.

One study examining individuals with “imagery neglect” demonstrated that these individuals had increased difficulty orienting themselves in an environment (Palermo, 2012). Imagery neglect is a form of navigational impairment. This impairment could be due to a deficit in creating or using a mental representation of the environment (Guariglia et al., 2005). In

imagery neglect patients, there is damage to the right side of the brain. This damage leads to an inability to attend to the left side of space and thus ignore it and do not perceive it. Imagery neglect is characterized by the failure to report the details of the left side of a mental image (Guariglia, 2013). In this study researchers examined individuals with imagery neglect to determine whether they had increased difficulty in topographical orientation. The researchers wanted to investigate whether imagery deficits of patients affect their ability to create and use cognitive maps. In this study they tested 28 brain damaged patients: half with imagery neglect and the other half without. They were tested on their ability to transform an egocentric orientation, an experience from their own perspective, into an allocentric one, an experience from a different perspective, and vice versa. The researchers concluded that imagery neglect patients had very poor allocentric representations of this environment and patients had difficulty in transforming an egocentric representation of the environment (Palermo, 2012). Therefore, they performed worse when trying to transform an orientation from a different perspective to their own perspective. Essentially, this research conveys that an impairment in visual imagery creates difficulty in spatial navigation and creating a cognitive map.

2) Memory

Researchers have suggested that visual imagery contributes to cognitive processes such as episodic memory, future event prospecting, visual working memory, and dreaming (Dawes et al., 2020). The human ability to remember and forget is another example of a cognitive domain that is a crucial evolutionary adaptation. Memory evolved because it helped us survive and reproduce; researchers have examined nature's criteria for a memory system as intricate as ours and why our memory system adapted to be the way that it is now (Klein et al., 2009). There are different types of memory and different forms of remembering. One of the most widely used

theoretical constructs in memory theory is encoding specificity. Encoding specificity suggests that memories are linked to the context that they are created (Tulving &Thomson, 1973). What matters in this context is the match between the environment when the memory was encoded and the environment when the memory is retrieved. Multiple researchers are focused on memory retrieval and specific retrieval environments. Researchers suggest that the retrieval of episodic memory specifically is linked to future thought. It is believed that episodic memories are the building blocks for future thought.

Some researchers suggest that visual imagery and memory retrieval are implemented by the same neural mechanism (Sakai & Miyashita, 1994). These shared mechanisms are present in the primate inferotemporal cortex. Memories stored in parts of the temporal association area are correlated to the generation of visual images in V4. Researchers have also established that attention influences the response in the temporal association area and V4 (Sakai & Miyashita, 1994). Centrally, these researchers have proposed that the same brain area used for memory retrieval for vision is used for visual imagery.

3) Language

Language is a vital element to human cognition that involves complex, patterned vocalizations. One of the most basic properties of human language is that each speaker can produce and interpret an endless number of expressions that could be understood by others (Berwick et al., 2013).

There is increasing evidence that visual imagery plays a role in language comprehension (Bell, 1991). Language comprehension is understanding the meaning of language, whether it is written or heard. Therefore making connections between concepts, words and sentences. When there are issues in language comprehension, for instance, a language comprehension disorder,

this is often caused because of a weakness or failure in creating a “gestalt,” or mental model of what the language is communicating. A gestalt helps individuals interpret language and create connections; it is a unit that is greater than the sum of its parts. A gestalt is created by visualization of a whole. What this means is that gestalt imagery allows the individual to create a mental model of language; this creates the ability to access prior knowledge and experiences in order to create language comprehension. A clinical study examining individuals with language comprehension disorder established, through reading comprehension tests, that gestalt imagery contributes to the comprehension of oral and written language (Bell, 1991).

Previous research has also looked at the effect that language can have on processing visual scenes (Dils & Boroditsky, 2010). This research examines the effect that linguistic content has on ambiguous visual scenes. In this study the researchers had participants interpret an ambiguous image that could have been perceived as either a bird flying in an upwards direction or a downwards direction. Before participants perceived the static image and disambiguated the direction of motion, participants had to either view real visual motion, either upward or downward, read a story describing physical motion, or read a story describing abstract motion (Dils & Boroditsky, 2010). The results of this study suggest that the interpretation of the ambiguous figure was affected by viewing actual motion or reading about a physical motion, but not by the description of abstract motion.

Researchers have also examined the relationship between signed languages and visual imagery. In a study examining both deaf and hearing users of American Sign Language, researchers investigated whether these individuals have an enhanced ability to create complex mental images and find mirror image reversals (Emmorey et al., 1993). The ability to detect mirror images refers to the ability to rotate objects in one's mind's eye. The basis of this study

was the observation that American Sign Language requires creating and perceiving fine visual-spatial distinctions, and this makes it plausible that they would have an enhanced use of visual imagery.

In this study, researchers investigated three visual mental imagery abilities that were hypothesized as integral to ASL production and comprehension: image generation, maintenance, and transformation (Emmorey et al., 1993). These abilities also reflect the typical progression of processing when imagery is used in cognition: an image is first generated, and it must be maintained in short-term memory in order to be manipulated. The research suggests that ASL signers were better than non-signers in specific aspects of visual imagery. The researchers found that deaf and hearing signers were better at generating visual mental images and detecting mirror reversals (Emmorey et al., 1993). However, there were no group differences in the ability to retain information in images for brief periods of time or to imagine objects rotating in individuals who signed and those who did not (Emmorey et al., 1993).

4) Morality

Visual imagery can make people feel an emotion more strongly (Wicken et al., 2021). When thinking of a morally wrong action, like stealing from a friend, you may or may not picture the crime in your mind's eye. Researchers suggest that there may be a connection between visualizing the event in your mind's eye and viewing it as morally wrong (Amit & Greene, 2012). There have been studies contrasting moral reasoning in individuals with more visual thinking styles and individuals with more verbal thinking styles. Researchers hypothesized that individuals with a verbal thinking style would make more utilitarian moral judgments while individuals with a visual thinking style would make more deontological moral judgments (Amit & Greene, 2012). Utilitarian moral judgments act on what is best for the majority, leading

decision makers to look for the greatest good for the greatest number of people. Deontological moral judgments focus on the protection of the individual and the protection of individual rights (Waller, 2005).

In this experiment, researchers tested the hypothesis that individuals with visual cognitive styles would make more deontological judgments and individuals with verbal cognitive styles would make more utilitarian judgments. In order to test this study researchers computed a visualizer-verbalizer score. This score represented the mean verbal accuracy subtracted from mean visual accuracy in the working memory tasks; higher numbers indicate a more visual cognitive style (Amit & Greene, 2012). Researchers gave participants seven high conflict dilemmas and measured the mean moral acceptability rating. The higher the rating the more utilitarian the judgment of the participant was and the lower the rating, the more deontological the judgment of the participant was. Analysis of the results suggest a negative correlation between visualizer-verbalizer score and mean moral acceptability rating; this means that participants with a more visual cognitive style had more deontological judgements. Therefore, a visual cognitive style has an effect on what kind of judgments a person will make given a certain situation.

5) Daydreaming

Daydreaming is a thought that is either spontaneous or imaginative. Daydreaming is distinguished by the fact that, if it represents reality at all, it is whimsical or visionary, not primarily constructive or reproductive, meaning that it does not rely on prior experiences or memories (Klinger, 2009). Daydreaming is a stream of thought that is unrelated to the present moment (Zedelius et al. 2020). Researchers have hypothesized that daydreaming and creativity are closely linked in that creativity facilitates daydreaming (Zedelius & Schooler, 2016).

Researchers suggest that daydreaming is a multifaceted concept; daydreams vary in style and concept. For example, there are three main styles of daydreaming. Firstly there is positive-constructive daydreaming, which is characterized by pleasant thoughts, vivid imagery, and planning. The second style of daydreaming is guilty-dysphoric daydreaming, which is characterized by unpleasant emotions such as guilt, fear of failure, and aggressive inclinations. The last form of daydreaming is poor attentional control, which is characterized by fleeting daydreams and general difficulty focusing attention on internal or external events (Singer and Antrobus, 1963). There are factors prevalent in people's daydreaming, such as mood, attentional focus, and intentionality, and these factors are related to creative processes (Zedelius & Schooler, 2016). These factors have an effect on the contents of the daydream; for example if you are in a hopeful mood you are going to have daydreams that reflect that such as getting a job promotion. Researchers have examined the relationship between daydreaming and visual imagery through studying oculomotor activity during daydreaming (Antrobus et al., 1964). The researchers found that eye movements and blinks were more frequent when participants were told to engage in active rather than passive thinking. The results of this study also suggest that individuals have greater ocular activity when imagining moving than when imagining still images (Antrobus et al., 1964).

Prior research suggests that there are links to visual imagery and degrees of creativity. Creativity includes the ability to create original work, not derived from anywhere else (Schmeidler, 1965). Other researchers have stated that creativity is the ability to see problems in a new light and think of solutions that are non conventional, the skill to recognize which ideas are worth pursuing and which are not, and the practical–contextual skill to know how to persuade others of the value of one's ideas (Sternberg, 1985). Researchers have gathered evidence to

suggest that a more visual mind is linked to a more creative mind. Scores on questionnaires of visual imagery and creativity show that there is a correlation between creativity scores and visual imagery scores (Schmeidler, 1965). Research suggests that multiple different creatives, whether it be for visual art or other forms of art such as music, have reported some degree of imagery when experiencing the creative process (LeBoutillier and Marks, 1953). More recent research suggests that different types of daydreaming can predict creativity (Zedelius et al. 2020). Since not all types of daydreaming lead to creativity researchers set out to find which types of daydreams relate to creativity. The different types of daydreaming in this study that were the most strongly related to creativity were personally meaningful daydreams and fantastical daydreams. The researchers examined future planning daydreams, pleasant daydreams, personally meaningful daydreams, unintentional daydreams, sexual daydreams, and fantastical daydreams. The researchers tracked daydreaming and daydreaming style in the lab and participants tracked this information outside of the lab via smartphone. Creativity was then assessed in the lab (Zedelius et al., 2020). What this research tells us is that specific styles of daydreaming are more closely related to creativity than others.

6) Rumination and Mental Health

Imagine you say something bad about a friend and they overhear your negative comment. Your friend cannot stop thinking about what you said and they replay that moment over and over again in their head. This is called rumination. Rumination is a form of perseverative cognition that focuses on negative content, generally past and present, and results in emotional distress (Sansone & Sansone, 2012). Rumination exacerbates depression, enhances negative thinking, impairs problem solving, interferes with instrumental behavior, and erodes social support. Rumination is a mode of responding to distress that involves repetitively and passively focusing

on symptoms of distress and on the possible causes and consequences of these symptoms. Rumination does not lead to active problem solving to change circumstances surrounding these symptoms (Hoeksema & Lyubomirsky, 2008).

Rumination is characterized by an abnormal and obsessive reflection over a certain idea or a choice. These negative mental images can represent unpleasant memories or non-memory-based scenes such as possible future disasters such as your house burning down or losing a loved one (Weßlau et al., 2015). Some researchers have suggested that this form of remembering comes from a useful, goal oriented and voluntary tool, meaning that the ability to replay an occurrence over in your head might have been useful as a survival tool (Berntsen & Jacobsen, 2008). Therefore, if you witnessed someone eat a poisonous plant and die shortly after, the ability to replay that memory in your mind would be useful for your own survival. This view is challenged by recent research which states that there is the occurrence of involuntary autobiographical memories (Berntsen & Jacobsen, 2008). This means that visual images in the mind's eye are not always intentionally summoned by the individual; sometimes, these memories and visual images that accompany them are involuntary. Therefore, if we go back to the example of your friend ruminating on that negative comment you made about them you could also say that they are not replaying that memory willingly. Rumination causes individuals to remember things that they might not want to remember. But not all forms of rumination are involuntary, they can also include intentionally produced images of future self-harm and suicidal ideation, as a form of "pre-experiencing" (Berntsen & Jacobsen, 2008).

Previous research suggests that visual imagery may have an effect on the onset and maintenance of depression and other mental health issues. It is through visual imagery that we are able to relive experiences and create hypothetical futures. Researchers examined individuals

with depression and surveyed the mental images that the individuals experienced. The results of the study suggest that individuals with depression are more likely to experience negative mental imagery such as violent self harm (Weßlau et al., 2015). Visual imagery is also a factor in other mental disorders such as post-traumatic stress disorder and anxiety. One study examined individuals with PTSD and individuals with low levels of anxiety (Bryant & Harvey, 1996). They used the Vividness of Visual Imagery Questionnaire to determine the extent of visual imagery in these individuals. The results of the study suggest that individuals with low anxiety have better visual imagery abilities compared to the PTSD participants. However, incidents of nightmares and flashbacks associated with visual imagery were more common in individuals with PTSD (Bryant & Harvey, 1996). Essentially, frequency and content of visual imagery is related to, and can be a defining feature of mental illness. Visual imagery plays a key role in mental illnesses characterized by hallucinations (Pearson et al., 2019).

Visual imagery is a factor in depression and other mental illnesses. Although it may generally be advantageous to clearly remember the details of past situations, there is a point when this imagery becomes intrusive and the driving cause for a mental disorder (Holmes et al, 2016). Dysfunctional visual imagery is intrusive and it can include harmful images such as imagery of past negative events, and suicidal imagery of the future (Holmes et al, 2016).

Research into methods to modify negative intrusive imagery in depression is recent in literature. Techniques include mental visual exposure to the problematic images to transform the content of the imagery using imagery rescripting (Holmes et al., 2016). Mental imagery techniques also form part of schema therapy, an integrative treatment approach to chronic and lifelong problems combining cognitive-behavioral, interpersonal, experiential, and psychodynamic techniques (Young et al. 2003). In schema therapy, mental imagery is used to

explore maladaptive schemas in patients and to change the emotional experiences associated with these schemas (Holmes et al., 2016).

Congenital Aphantasia

Individuals with aphantasia make up a small group of the population and they report having a "blind mind" (Keogh & Pearson, 2018). Past research on aphantasia has explored the differences in the cognitive experience of individuals with and without aphantasia. A recent study showed that individuals with aphantasia experience less rich autobiographical memories, with some reporting decreased imagery in other sensory domains (Dawes et al., 2020). Participants with aphantasia report difficulty with face recognition and autobiographical memories (Zeman et al., 2020). This means that people with aphantasia have difficulty remembering faces and their own life events. In one study, (Dawes et al., 2020), researchers recruited aphantasic participants from a Facebook group online; participants completed the Vividness of Visual Imagery Questionnaire and the Episodic Memory Imagery Questionnaire. The Episodic Memory Imagery Questionnaire aims to assess the vividness of episodic memories that an individual experiences. Researchers also examined the frequency and vividness of daydreams and night dreams that participants experienced using the Imaginal Process Inventory. Lastly, participants completed a trauma response questionnaire, the PTSD Checklist for DSM-5, which measures self-reported responses to stressful life events. It asks participants to indicate how much they have been bothered by a problem related to a stressful life event on a 5-point scale. The results of this study suggest that aphantasic participants have a significantly lower ability to remember life events. Not only did aphantasic individuals report difficulty with remembering past life events, but they also struggled with imagining future events using any sensory details. Semantic memory was also reported to be lower in individuals with aphantasia

compared to controls. The results from this study also showed that the lack of visual imagery in individuals did not prevent trauma symptomatology in relationship to PTSD. As for daydreams and night dreams, participants with aphantasia did not show a significant difference in the amount of mind wandering compared to controls. However, participants reported having fewer night dreams (Dawes et al., 2020). This study touches upon some of the differences that aphantasics experience in regard to mental illness and daydreaming. This study could be used as a foundation to further explore the effects of different types of daydreaming in individuals with aphantasia and the possible relationship present with creativity. Another possible extension of this study would include studying specific symptoms of mental illness such as rumination.

Previous research examining spatial memory and spatial imagery ability suggest that there is no difference in these abilities in individuals with aphantasia and individuals without; However, aphantasics do show differences in object memory performance during drawing tasks (Bainbridge et al., 2021). In one study, participants participated in an online drawing recall task. Participants were recruited from aphantasia-specific forums, and their lack of visual imagery was confirmed with the use of the VVIQ. Weak visual imagery ability is typically defined by a total score of 32 or less on the VVIQ. The VVIQ is a five-point Likert self-report scale which ranges from 16–80. A total score of 32 is equivalent to rating one's agreement on every questionnaire item at 2 which is classified as "Vague and dim" (Dawes et al., 2020) . While there is no established cut off to determine what score indicates aphantasia, this study and others have used a score of 32 or lower as an indicator that an individual has aphantasia (Bainbridge et al., 2021). In the experiment itself, participants were asked to study an image, recall, recognize, and recreate the image in a drawing. The results of this study suggest that there are differences in object memory among participants. Control participants showed a significantly higher ability in object

memory. Object memory was assessed through the drawing of the images produced by the participants. The participants drew the image that they were told to remember and the researchers measured the amount of objects that were left out or objects that were not in the original image. There was also an object remembering task where participants were shown objects and they had to determine if the object was in the original image. Results also suggest that individuals with aphantasia performed equally well on tests of spatial memory (Bainbridge et al., 2021). Spatial memory was also measured with a drawing task where participants had to recreate the original image to the best of their ability. The spatial memory task was measured by placing and resizing an oval around an object in the drawing, in order to get information on the location and size accuracy of the objects in the drawings. Object location and size were taken as the median pixel values across the five scorers (Bainbridge et al., 2021). Essentially, individuals with aphantasia do experience some types of memory such as spatial memory, in the same way that people without aphantasia do.

Aphantasia also has an effect in other areas of life. For example, individuals with aphantasia report having more scientific and mathematical professions as opposed to "creative" occupations, like a song writer or a visual artist, (Zeman et al., 2020). Studies on aphantasia have also suggested possible links between weakened visual imagery and autism spectrum disorders (Dance et. al, 2021). Autism is associated with a variety of developmental differences in social cognition, communication, sensory sensitivity, and imagination (American Psychiatric Association, 2013). Dance and colleagues (2021) examined the rates of autism in aphantasic participants and controls using the Autism Spectrum Quotient test (AQ), which is a self-report measure of autism-related traits. The results showed that people with aphantasia had higher AQ scores compared to controls. This research was conducted on the basis that children diagnosed

with autism participate in less imaginative activities such as pretend play and imaginative drawings. Nonetheless, it is important to note that imagination and visual imagery are not interchangeable terms. Individuals with aphantasia can use their imagination without having any visual imagery; there are multiple creatives such as writers and artists with aphantasia (Zeman et al., 2019). Additionally, studies have examined whether synesthesia and aphantasia can occur and results have suggested that grapheme-color synaesthesia can exist within people with aphantasia, and it is just as common in people with aphantasia and people without (Dance et al., 2021).

Discussion and proposal for future research

Since visual imagery has been linked to a number of aspects important in everyday life such as spatial navigation, memory, and language comprehension it can be hard to imagine how someone can live without access to what seems like a vital part of these functions. Nonetheless, research on individuals with aphantasia report that they are mostly capable of these functions, albeit without the use of conscious visual imagery. Individuals with aphantasia show some cognitive differences, whether it be in autobiographical memory (Dawes et al., 2020) or imagination (Dance et al., 2021), yet they also show that they are capable of the same tasks as someone with visual imagery.

So how does the absence of visual imagery in individuals with aphantasia affect these specific cognitive domains? We have established that visual imagery is a part of multiple different cognitive domains so can we then establish that individuals with aphantasia do not experience domains in the same way that someone who can use visual imagery does? This is not necessarily true. We cannot assume that a lack of visual imagery indicates poorer cognitive function in cognitive domains that utilize visual imagery. We cannot assume that since an

individual does not experience visual imagery, they do not experience daydreaming or rumination. In tests of memory, we can see that individuals with aphantasia have decreased abilities in some areas but function just as well as controls in others (Dawes et al. 2020). Additionally, one might assume that aphantasics would not experience synesthesia on the same level as people without synesthesia because synesthesia is associated with enhanced imagery abilities (Dance et al., 2021), however, individuals with aphantasia are just as likely to have synesthesia (Dance et al., 2021).

Therefore we cannot definitely determine the effects that the lack of visual imagery has on cognitive domains. We cannot assume that a lack of visual imagery causes decreased daydreams and therefore decreased creativity; there are multiple creatives that are affected by aphantasia (Zeman et al., 2019). Additionally, we cannot assume that individuals with aphantasia experience less rumination and therefore less depression. Prior research has stated that the lack of visual imagery an individual experiences does not affect symptom severity in mental disorders (Bryant & Harvey, 1996) but prior research studies have shown that visual depressive cognitive styles, compared to verbal depressive cognitive styles, are more commonly found in individuals with worsened symptoms of depression (Lawrence et al., 2018).

The current research on aphantasia does not evaluate what types of daydreaming people with aphantasia experience. This link between style of daydreaming and creativity could be useful in studying individuals with aphantasia. Moreover, it is possible that individuals with aphantasia do not experience the types of daydreaming that are most closely related to creativity. Additionally, there is research regarding the differences in symptoms for individuals with aphantasia compared to those without; however they do not address rumination, a largely visual component of certain mental illnesses, or creativity specifically.

Possible future research to address some of these concerns could be a correlational study using the VVIQ to test the extent of visual imagery in an individual as well as other tests such as the 22-item ruminative response scale to test the extent of depression and rumination in individuals. This study would recruit individuals from online forums that claim to have aphantasia and this would be confirmed using the Vividness of Visual Imagery Questionnaire. It would then ask participants about whether they had ever experienced rumination or depression using the 22-item ruminative response scale. Possible future research also includes a test of creative abilities and daydreaming to see whether decreased visual imagery leads to less creativity and therefore less daydreaming or vice versa. This study would also track the style of daydreaming, not just frequency that daydreams occur. This would be in the form of a correlational study where participants would rate the frequency vividness and style of their daydreams and take a test of their visual creativity such as the Test of Creative Imagery Abilities (TCIA).

Conclusion

Visual imagery plays a role in multiple different cognitive domains, is present in certain types of daydreaming, and can even play a role in certain mental illnesses. Individuals with aphantasia do not possess the ability to see in their mind's eye, but the extent of the effect that this has on specific cognitive functions is unknown. Researchers have established that there are some differences in memory, such as decreased object memory, but research also suggests that other types of memory function in the same way as people who do not have aphantasia, such as spatial memory.

Prior research has assessed the differences in daydreaming and symptoms of mental illness in individuals with aphantasia. The results suggest that participants do not show a

significant difference in the amount of mind wandering compared to controls; however, researchers measured the frequency of daydreams and not the daydreaming style. Therefore, future research is needed to address specific daydreaming styles, such as future planning daydreams, pleasant daydreams, personally meaningful daydreams, unintentional daydreams, sexual daydreams, and fantastical daydreams, in individuals with aphantasia and measure the relationship between daydreamin and creativity in this population. Additionally, previous research has suggested that individuals with aphantasia that have been diagnosed with PTSD have the same symptoms as individuals without aphantasia and a PTSD diagnosis. This research could be expanded by focusing on ruminative symptoms of mental illness. Other researchers have suggested that visual cognitive styles are more closely related to depression. Future research would measure rumination specifically in individuals with aphantasia to see whether aphantasics might be less prone to ruminative depression.

All in all, the existing research on aphantasia paves the way for more extensive research regarding aspects such as daydreaming and creativity, as well as rumination and its relationship to mental illness.

References

Albers A.M., Kok P., Toni I., Dijkerman H.C., de Lange F.P. (2013). Shared representations for working memory and mental imagery in early visual cortex. Curr Biol 23(15):1427–1431

American Psychiatric Association (2013). Diagnostic and statistical manual of mental disorders (5th ed.). https://doi.org/10.1176/appi.books.9780890425596.

Antrobus, J. S., Antrobus, J. S., & Singer, J. L. (1964). Eye movements accompanying daydreaming, visual imagery, and thought suppression. *The Journal of Abnormal and Social Psychology, 69*(3), 244–252. https://doi.org/10.1037/h0041846

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, 135*, 159-172. doi:10.1016/j.cortex.2020.11.014

Baron-Cohen, S., Wheelwright, S., Stott, C., Bolton, P., & Goodyer, I. (1997). Is there a link between engineering and autism? *Autism*, *1*(1), 101–109. https://doi.org/10.1177/1362361397011010

Bechtel, W. (2003). Modules, Brain Parts, and Evolutionary Psychology. *Evolutionary Psychology*, pp. 211–227., https://doi.org/10.1007/978-1-4615-0267-8_10.

Bell, N. (1991). “Gestalt Imagery: A Critical Factor in Language Comprehension.” *Annals of Dyslexia*, vol. 41, no. 1, pp. 246–260., https://doi.org/10.1007/bf02648089.

Berntsen, D. and Jacobsen, A. S. (2008). “Involuntary (Spontaneous) Mental Time Travel into the Past and Future.” *Consciousness and Cognition*, vol. 17, no. 4, pp. 1093–1104., https://doi.org/10.1016/j.concog.2008.03.001.

Berwick R.C., Friederici A.D., Chomsky N., Bolhuis J.J. (2013). Evolution, brain, and the nature of language. *Trends in Cognitive Sciences*, 17 (2) , pp. 89.

Bryant, R. A., & Harvey A. G. (1996). “Visual Imagery in Posttraumatic Stress Disorder.” *Journal of Traumatic Stress*, vol. 9, no. 3, pp. 613–619., https://doi.org/10.1002/jts.2490090317.

Cushman F, Young L, Hauser M. (2006). The role of conscious reasoning and intuition in moral judgment: testing three principles of harm. *Psychological Science*. 17 (12): 1082–9. doi:10.1111/j.1467-9280.2006.01834.x. PMID 17201791. S2CID 17294896.

Dance, C. J., Jaquiery, M., Eagleman, D. M., Porteous, D., Zeman, A., & Simner, J. (2021). What is the relationship Between APHANTASIA, synaesthesia and autism? *Consciousness and Cognition*, *89*, 103087. https://doi.org/10.1016/j.concog.2021.103087

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

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). doi:10.1038/s41598-020-65705-7

Dils, A. T., & Boroditsky, L. (2010). Processing unrelated language can change what you see. *Psychonomic bulletin & review*, *17*(6), 882-888.

Emmorey, K., Kosslyn, S. M., Bellugi, U. (1993).“Visual Imagery and Visual-Spatial Language: Enhanced Imagery Abilities in Deaf and Hearing ASL Signers.” *Cognition*, vol. 46, no. 2, pp. 139–181., https://doi.org/10.1016/0010-0277(93)90017-p.

Epstein, R., Patai, E., Julian, J. (2017). The cognitive map in humans: spatial navigation and beyond. *Nat Neurosci* 20, 1504–1513. https://doi.org/10.1038/nn.4656

Ganis, G., Thompson, W. L., & Kosslyn, S. M. (2004). Brain areas underlying visual mental imagery and visual perception: An fmri study. *Cognitive Brain Research*, *20*(2), 226–241. https://doi.org/10.1016/j.cogbrainres.2004.02.012

Guariglia, C., Piccardi, L., Iaria, G., Nico, D., & Pizzamiglio, L. (2005). Representational neglect and navigation in real space. *Neuropsychologia, 43*(8), 1138–1143. https://doi.org/10.1016/j.neuropsychologia.2004.11.021

Guariglia, C., Palermo, L., Piccardi, L., Iaria, G., & Incoccia, C. (2013). Neglecting the left side of a city square but not the left side of its clock: Prevalence and characteristics of representational neglect. *PLoS ONE, 8*(7). doi:10.1371/journal.pone.0067390

Hoeksema, N. S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science, 3*(5), 400-424. doi:10.1111/j.1745-6924.2008.00088.x

Holmes, E. A., Blackwell, S. E., Heyes, B. S., Renner, F., & Raes, F. (2016). Mental imagery in DEPRESSION: Phenomenology, potential mechanisms, and Treatment Implications. *Annual Review of Clinical Psychology*, *12*(1), 249–280. https://doi.org/10.1146/annurev-clinpsy-021815-092925

Houwer, J. & Hermans, D. (1994). "Differences in the Affective Processing of Words and Pictures." *Cognition & Emotion*, vol. 8, no. 1, pp. 1–20., https://doi.org/10.1080/02699939408408925.

Jacobs, C., Schwarzkopf, D. S., & Silvanto, J. (2018). Visual working memory performance in aphantasia. *Cortex, 105*, 61-73. doi:10.1016/j.cortex.2017.10.014

Keogh, R., & Pearson, J. (2018). The blind mind: No sensory visual imagery in aphantasia. *Cortex, 105*, 53-60. doi:10.1016/j.cortex.2017.10.012

Klein, S. B., Robertson, T. E., & Delton, A. W. (2009). Facing the future: Memory as an evolved system for planning future acts. *Memory & Cognition, 38*(1), 13-22. doi:10.3758/mc.38.1.13

Klinger, E. (2009). *Daydreaming and fantasizing: Thought flow and motivation.*:Klinger, E. (2009). *Daydreaming and fantasizing: Thought flow and motivation.* In K. uD.

Kosslyn S. M. (1973) Scanning visual images: Some structural implications. Percept Psychophys 14(1):90–94.

Kosslyn, S. M., Thompson, W. L., & Alpert, N. M. (1997). Neural systems shared by visual imagery and Visual Perception: A positron emission Tomography Study. *NeuroImage*, *6*(4), 320–334. https://doi.org/10.1006/nimg.1997.0295

Langland‐Hassan, P. (2020). Inner speech. *WIREs Cognitive Science, 12*(2). doi:10.1002/wcs.1544

Lawrence, H. R., Haigh, E. A., Siegle, G. J., & Schwartz-Mette, R. A. (2018). Visual and verbal depressive cognition: Implications for the rumination–depression relationship. *Cognitive Therapy and Research*, *42*(4), 421–435. https://doi.org/10.1007/s10608-018-9890-0

LeBoutillier, N., Marks, D.F. “Mental Imagery and Creativity: A Meta-Analytic Review Study.” *British Journal of Psychology (London, England : 1953)*, U.S. National Library of Medicine, https://pubmed.ncbi.nlm.nih.gov/12648387/.

Markman, W. M. P. Klein, & J. A. Suhr (Eds.), *Handbook of imagination and mental simulation* (p. 225–239). Psychology Press.

Marks, D. F. (1973). Visual imagery differences in the recall of pictures. *British Journal of Psychology*, *64*(1), 17–24. https://doi.org/10.1111/j.2044-8295.1973.tb01322.x

Marks, D. F. (1999). Consciousness, mental imagery and action. *British Journal of Psychology*, *90*(4), 567–585. https://doi.org/10.1348/000712699161639

Mellet, E., Petit, L., Mazoyer, B., Denis, M., & Tzourio, N. (1998). Reopening the mental imagery debate: Lessons from functional anatomy. *NeuroImage*, *8*(2), 129–139. https://doi.org/10.1006/nimg.1998.0355

Meyer, T. D., Finucane, L., & Jordan, G. (2011). Is risk for mania associated with increased daydreaming as a form of mental imagery? *Journal of Affective Disorders*, *135*(1-3), 380–383. https://doi.org/10.1016/j.jad.2011.06.002

Palermo, L., Ranieri, G., Nemmi, F., Guariglia, C. (2012). "Cognitive Maps in Imagery Neglect." *Neuropsychologia*, vol. 50, no. 5, pp. 904–912., https://doi.org/10.1016/j.neuropsychologia.2012.01.030.

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

Pearson, J. & Kosslyn, S. M. (2015). "The Heterogeneity of Mental Representation: Ending the Imagery Debate." *Proceedings of the National Academy of Sciences*, vol. 112, no. 33, pp. 10089–10092., https://doi.org/10.1073/pnas.1504933112.

Roebuck, H., & Lupyan, G. (2019). The internal representations questionnaire: Measuring modes of thinking. https://doi.org/10.31234/osf.io/euhcn

Sansone, R. A., Sansone L.A. (2012). Rumination: Relationships with Physical Health. Innov Clin Neurosci. 2012 Feb; 9(2): 29–34. Published online 2012 Feb. PMCID: PMC3312901

Shepard, R. N., & Metzler, J. (1971). Mental rotation of three-dimensional objects. *Science, 171*(3972), 701–703. https://doi.org/10.1126/science.171.3972.701

Thomas, Nigel J.T., "Mental Imagery", *The Stanford Encyclopedia of Philosophy* (Fall 2021 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/fall2021/entries/mental-imagery/>.

Vaitl, D., Birbaumer, N., Gruzelier, J., Jamieson, G. A., Kotchoubey, B., Kübler, A., Lehmann, D., Miltner, W. H., Ott, U., Pütz, P., Sammer, G., Strauch, I., Strehl, U., Wackermann, J., & Weiss, T. (2005). Psychobiology of altered states of consciousness. *Psychological Bulletin*, *131*(1), 98–127. https://doi.org/10.1037/0033-2909.131.1.98

Waller, N. 2005. Consider Ethics: Theory, Readings, and Contemporary Issues. New York: Pearson Longman. p. 23.

Warner, L., & McNeill, M. E. (1988). Mental imagery and its potential for physical therapy. *Physical Therapy*, *68*(4), 516–521. https://doi.org/10.1093/ptj/68.4.516

Weßlau, C., Cloos, M., Höfling, V. (2015). Visual mental imagery and symptoms of depression – results from a large-scale web-based study. *BMC Psychiatry* 15, 308. https://doi.org/10.1186/s12888-015-0689-1

Wicken, M., Keogh, R., & Pearson, J. (2021). The critical role of mental imagery in human emotion: Insights from fear-based imagery and aphantasia. *Proceedings of the Royal Society B: Biological Sciences*, *288*(1946), 20210267. https://doi.org/10.1098/rspb.2021.0267

Winawer, J., Huk, A. C., & Boroditsky, L. (2010). A motion aftereffect from visual imagery of motion. *Cognition*, *114*(2), 276–284. https://doi.org/10.1016/j.cognition.2009.09.010

Zedelius, C. M., & Schooler, J. W. (2016). The richness of inner Experience: Relating styles of Daydreaming to creative processes. *Frontiers in Psychology, 6*. doi:10.3389/fpsyg.2015.02063

Zedelius, C. M., Protzko, J., Broadway, J. M., & Schooler, J. W. (2020). What types of daydreaming predict creativity? Laboratory and experience sampling evidence. *Psychology of Aesthetics, Creativity, and the Arts*.

Zeman, A., Onians, J., Macpherson, F., Aldworth, S., Winlove, C., & MacKisack, M. (2019). Extreme Imagination - inside the mind's eye. [Exhibition Catalogue]. Exhibitied at Royal Albert Memorial Museum, Exeter 30/03/19-02/06/19.

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. https://doi.org/10.31234/osf.io/sfn9w

Zvyagintsev, M., Clemens, B., Chechko, N., Mathiak, K. A., Sack, A. T., & Mathiak, K. (2013). Brain networks underlying mental imagery of auditory and visual information. *European Journal of Neuroscience*, *37*(9), 1421–1434. https://doi.org/10.1111/ejn.12140