

AN EXPLORATION OF MENTAL HEALTH AND VISUAL IMAGERY

By

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Abstract

Mental imagery appears to play an important role in a number of mental health conditions including depression, anxiety, PTSD, bipolar disorder, and others. However, there is a condition called aphantasia in which people may lack the ability to form mental imagery at all. Thus, people with aphantasia or decreased visual imagery abilities may experience depression or anxiety at different rates, or they may just experience these conditions differently compared to people without aphantasia. This paper used data related to visual imagery, depression, anxiety, and well-being from surveys as well as Mind Window, an experience sampling mobile app that collects information on its users everyday thoughts, in order to look for patterns in thinking. Analyses showed that there may be a relationship between lower levels of mental imagery and higher levels of depression as well as between lower levels of mental imagery and lower levels of well-being. This could be due to less effective positive imagery capabilities or overgeneralized memories.

Introduction

When asked to think about a close family member or friend, most people can conjure an image of that person in their mind. They can see the details in their features, the expression on their face, the clothes that they are wearing. This is called visual imagery, which is a vital piece of the puzzle that is a person's imagination. Imagination can be defined as "the power or capacity to form internal images or ideas of objects and situations not actually present to the senses" (Oxford English Dictionary, 2023). The imagination is believed to be made up of two general parts: the mind's eye and the mind's mind (Andrews-Hanna and Grilli, 2021). Visual imagery is part of the mind's eye. Our ability to daydream, recreate images, visualize spatial memories, re-experience past events, and construct novel mental images and future scenarios is contained within the mind's eye. The mind's mind is the more verbal or conceptual aspect of the imagination, what some people may refer to as an internal monologue. The mind's mind is what allows us to reflect on our past experiences, analyze, and think critically. Both the mind's eye and the mind's mind appear to be vital aspects of the imagination. However, there are some people who completely lack a mind's eye and exclusively rely on the mind's mind. This is called aphantasia which is a condition characterized by an inability to form or experience visual imagery. Recent estimates show that aphantasia may be present in up to 4% of the population (Dance & Simner, 2022). However, aphantasia does not appear to be a disorder, but rather just a variation in the human mind. Hyperphantasia is essentially the opposite of aphantasia and is characterized by extremely vivid visual imagery. Individuals with hyperphantasia tend to rely more heavily on their mind's eye rather than their mind's mind, however, it does not necessarily mean that they lack a mind's mind. There is a spectrum of mental imaging abilities with aphantasia and hyperphantasia being on opposite ends of the spectrum.

Research on aphantasia and hyperphantasia is fairly limited because it is a relatively new area of study. The term aphantasia was only coined in 2015 by researcher and Professor of Cognitive and Behavioral Neuroscience, Adam Zeman (Zeman, 2015). The term comes from the Greek word, phantasia, which means imagination. However, some research was done on aphantasia, before the term was introduced, as early as 1880. In 1880, Francis Galton completed a study in which he asked participants to imagine their breakfast table in front of them and to imagine the illumination, definition, and coloring of different aspects of their breakfast table (Galton, 1880). Through this, he discovered that there are people who do not experience mental imagery.

The existing research on aphantasia has shown that it may have implications for many aspects of the mind including memory (Keogh et al., 2021), future thinking (D'Argembeau & Van der Linden, 2006), emotion (Holmes & Mathews., 2005), dreaming (Dawes et al., 2020) and potentially mental health as well.

Mental health conditions like depression and anxiety are very common in the United States. It is estimated that 21 million or 8.4% of adults in the U.S. have had at least one major depressive episode (NIH, 2022). It is estimated that 31.1% of adults in the U.S. will experience an anxiety disorder in their lives (NIH, n.d.). Both anxiety and depression have a higher prevalence among women. Learning more about these conditions and the variations that exist between them can allow us to better recognize and treat them.

Intrusive and maladaptive imagery is a key feature of many mental health conditions including anxiety and depression as well as PTSD, bipolar disorder, schizophrenia and others. Since aphantasics do not have the capacity for visual imagery, they may experience these conditions differently. There is very little research so far on the relationship between aphantasia

and mental health, however, there is existing research on mental imagery which can guide current and future research into this subject.

Increased levels of negative mental imagery appears to be a symptom of depression (Weßlau & Steil, 2014; Holmes et al. 2016; Görge et al. 2015). Intrusive imagery of negative past events as well as future imagery involving suicide are both features of major depressive disorders (Holmes et al. 2016). Vivid memories of past failures, humiliation, sadness and trauma can unwillingly invade a person's mind and can evoke intense feelings of sadness, anger, fear, and guilt which can then exacerbate depressive symptoms. In addition to the elevated levels of negative imagery, people with depression may also experience a scarcity of positive mental imagery (Holmes et al. 2016). They may find it difficult to generate positive future scenarios or remember positive events from the past. If asked to imagine a joyful time in the future, their imagined scenario may lack detail, or they may have difficulty formulating a scenario altogether compared to non-depressed people. Positive and negative mental imagery have been shown to amplify affect. For a healthy individual, imagining positive future events may induce a positive mood, but this may not be as powerful in someone with depression. Additionally, they may not be able to recall past positive memories as vividly as a non-depressed person.

One study by Görge et al. from 2015 looked at the role that positive and negative mental imagery played in depression. This study used the Affect Misattribution Procedure (AMP) and the Self-Assessment Manikin (SAM) to measure the implicit and explicit affect induced by mental imagery, photos, and words in people with a depressive disorder compared to healthy controls. They found that negative mental imagery elicited stronger negative affect in individuals with depression compared to controls. However, they also found that in those with depression, the effects of mental imagery were similar to the pictures and verbal processing conditions. One

possible explanation for the lack of emotional amplification of imagery is that forming mental imagery requires recall of related memories, and people with depression tend to have memory deficits. This study also found that participant's with depression experienced less positive affect in the explicit condition and that an increased use of mental imagery in daily life was correlated with an increased implicit positive affect in those with depression. This indicates that positive imagery could be useful in the treatment of depression.

There seems to be less research on the effects that mental imagery can have in anxiety, however, it does still appear to play a role similar to that of depression. Individuals with anxiety have reported increased levels of intrusive prospective mental imagery in both number and intensity of experiences (Tallon et al. 2020). They may imagine negative future scenarios more frequently and assess them as more likely to occur compared to people without anxiety. Negative future-oriented imagery has been shown to be especially relevant to social anxiety.

The use of positive imagery in the treatment of both anxiety and depression has been shown to be beneficial. One study by Landkroon et al. from 2022 explored the effects of positive prospective mental imagery as a treatment for anxiety, specifically to enhance exposure therapy for public speaking. Participants with moderate public speaking anxiety were assigned either to a positive mental imagery condition or to a control condition. Before completing the public speaking task, they rated their anticipatory anxiety, willingness to participate in the task, and their mood. Those in the positive imagery condition listened to an audio that asked them to vividly imagine themselves successfully giving a speech. Then participants completed the ratings again and completed a virtual reality public speaking task. They found that those in the positive imagery condition experienced less anticipatory anxiety and distress while giving the speech. However, it did not improve exposure willingness. The researchers inferred that positive mental

imagery may promote reappraisal of feared events and encourage the imagining of constructive behaviors which can reduce anxiety. Another study looked at the effects of prospective mental imagery on reward processing, motivation and behavior in those with depression (Renner et al., 2021). They found that imagining participating in positive activities can increase reward anticipation and motivation, which can in turn increase engagement in those rewarding experiences, which may decrease symptoms of depression. This may assist in reducing anhedonia, or the lack of interest in activities that the person previously enjoyed. which is a common symptom of depression. These studies indicate that treatments for depression and anxiety may benefit from the inclusion of positive prospective mental imagery exercises.

However, individuals with aphantasia lack mental imagery, so they may experience depression and anxiety differently. It is possible that aphantasia may be protective to an extent against depression and anxiety because they can not vividly imagine themselves in negative past or future scenarios. However, if people with aphantasia or lower imagery abilities do have depression and anxiety, they may not benefit as much from treatments that involve positive mental imagery.

Although very limited, there has been some research specifically on aphantasia as it relates to affect as well as to mental health. One study by Wicken and Pearson from 2021 examined aphantasia and the role of imagery in emotional amplification. They tested whether aphantasics had a dampened emotional response to frightening stories compared to people with typical mental imaging abilities by measuring skin conductance levels while aphantasics and non-aphantasics read frightening stories. They found that aphantasics exhibited reduced skin conductance levels after reading the frightening scenarios compared to the non-aphantasics, which could indicate a reduced fear response to frightening verbal stimuli. However, they also

ran a control experiment which followed essentially the same procedure except that participants were shown frightening photographs rather than frightening stories. Aphantasics and non-aphantasics had similar skin conductance levels in response to frightening images which indicates that aphantasics may not have a reduced overall fear response, only in response to fearful mental imagery. Having a reduced emotional response to negative imagined stimuli could potentially prevent the continuation of negative mental states, thus reducing the prevalence of anxiety and depression in aphantasics. However, mental imagery is only one aspect of depression and anxiety, and individuals may experience these conditions in very different ways. There was one study that looked at PTSD symptoms in response to past stressful events in people with aphantasia (Dawes et al., 2020). They expected that the lack of mental imagery would partially protect them from symptoms such as vivid intrusive memories, however, they did not find any significant differences between aphantasics and non-aphantasics. A lack of mental imagery could also potentially have the opposite effect and could increase depressive or anxious symptoms through mechanisms such as rumination. Rumination refers to negative repeated thoughts which can result in distressing feelings and it is a common symptom of depression as well as anxiety. It is typically thought of as a verbal thought process which is why it could be more prevalent in those with aphantasia.

Overall, mental imagery appears to play an important role in anxiety and depression, but how this relates to aphantasics is still widely unknown. There is also very little data on aphantasia collected outside of a lab, using experience sampling or other more naturalistic methodologies. This paper seeks to explore the relationship between aphantasia and mental health conditions including depression and anxiety using data collected from the Mind Window app as well as other questionnaires. The Mind Window app has amassed a great deal of data

about peoples' everyday thoughts by repeatedly and randomly asking its users about their current thoughts. Looking at data regarding the everyday thoughts of aphantasics, hyperphantasics, and everyone in between may allow us to better understand the relationship between mental imagery and depression and anxiety.

Hypotheses:

It is expected that aphantasia or lower visual imagery abilities will be associated with lower levels of anxiety and depression potentially due to the lack of negative mental imagery and decreased emotional responses to negative mental stimuli. It is also expected that people with decreased visual imagery may have increased or more moderate levels of well being compared to those with greater imagery abilities. The lack of mental imagery may partially protect them from extremely negative emotional responses, but it may also mute positive emotional responses. Even though aphantasics may have lower levels of anxiety and depression overall, they may be more prone to rumination since that is a primarily verbal form of maladaptive thinking. It is also hypothesized that aphantasics who do have depression or anxiety may experience a higher level of overall well-being compared to non-aphantasics with depression or anxiety.

Methods

Participants:

The sample consisted of 536 participants (430 female, 95 male, 11 non-binary or other). The mean age is 20.06 ranging from 18 to 82 years of age. Most participants were college aged students completing this study for course credit in the Psychology Department at the University of Arizona. All participated in this study during the Spring 2022, Fall 2022, and Spring 2023 semesters. 296 participants identified their race as non-Hispanic White, 130 as Latinx, Hispanic, or Hispanic American, 43 as Asian or Asian American, 36 as multiracial, 19 as Black or African American, 13 as Native American, Alaska Native, First Nations, or Indigenous, 4 as Middle Eastern, 2 as Native Hawaiian or Other Pacific Islander, and 6 preferred not to answer. All participants completed a survey on Qualtrics (described below under SONA Study) and completed at least 10 check-ins on the Mind Window app (described below under Mind Window) with the average number of check-ins being 30. 32 participants were identified as aphantasic with a VVIQ score of less than two and 14 were identified as hyperphantasic with a VVIQ score of five. A subsample consisting of the 32 aphantasics (Mean age = 21, 25 Female) and 32 randomly selected non-aphantasics (Mean age = 19.8, 25 Female) was used for some analyses.

Materials and Procedures:

SONA Study:

All data used in this paper was obtained by a study from Dr. Jessica Andrews-Hanna's Neuroscience of Emotion and Thought Lab at the University of Arizona. The study was completed via SONA, the experiment scheduling and tracking system utilized by the University of Arizona Psychology Department. Participants signed up for this fully online study on SONA.

They were compensated with credits that may be required by some University of Arizona courses. After signing up, they were guided to a survey on the Qualtrics research platform where they were provided with an introduction and overview of the study, a consent form, and a number of questionnaires of interest to the lab. These questionnaires include the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973), the 8-question Patient Health Questionnaire (PHQ-8; Kroenke et al., 2001), the 7-item Generalized Anxiety Disorder Assessment (GAD-7; Spitzer et al., 2006), the Mindful Awareness Attention Scale (MAAS; Brown & Ryan, 2003), and the UCLA Loneliness Scale Version 3 (Russell et al., 1978). among others (see below for more details). Within this survey, participants were also asked to download the Mind Window app to their phones which is an app designed to collect data about its user's everyday thoughts. More detail about Mind Window is provided in the following section. Participants were then asked to complete at least 30 check-ins on the Mind Window app over a one-week study period where they returned to the app and answered questions about what they were just thinking about. After the study period ended, participants were sent a debriefing form via email which contains two true or false questions that they must respond to in order to receive credit for their participation. All procedures were approved by the University of Arizona Internal Review Board.

Mind Window:

Mind Window is a mobile app for apple and android devices developed by Eric Andrews, a doctoral student in the Dr. Jessica Andrews-Hanna's Neuroscience of Emotion and Thought Lab. It was designed to find patterns in everyday thinking. Thousands of people have used the app and it has created a database of information about people's everyday thoughts over time. When people first download the app and create an account, they complete a number of required one-time questionnaires about their demographics, mental health history, health history,

personality, well-being, sleep, and overall questions about their thoughts among other questions. After completing these surveys, users are notified randomly six times each day to check in on the app and answer a number of questions about what they were just thinking about. They must respond to the notification within 10 minutes, or the check-in will disappear. At every check-in they are asked 14 questions in total: 12 core questions which always remain the same and 2 rotating questions which come from a pool of 10 questions. An example of a core question is “in the moments just before the notification, to what degree were you actively directing what was on your mind?” The final core question is an optional free response question in which users can describe what they were thinking about. An example of a rotating question is “regarding your thoughts in the moments just before the notification, how productive or helpful do you think they were?” All participants in these analyses completed the Qualtrics survey and at least 10 check-ins on the Mind Window app. There are also a number of optional one-time questionnaires that users can complete on their own time if they choose to.

Measures and Questionnaires:

The Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) was used to assess visual imagery abilities among participants. Participants responded to the VVIQ on the Qualtrics survey. The VVIQ is a 16-item questionnaire which asks participants to imagine four different scenarios and rate how vividly they can visualize them in their mind’s eye. One scenario asks people to “visualize a rising sun. Carefully consider the picture that comes before your mind’s eye.” Then they rate four different aspects of this mental image on a five-point scale given the options “perfectly realistic, as vivid as real seeing,” “realistic and reasonably vivid,” “moderately realistic and vivid,” “dim and vague image,” or “no image at all, I only “know” I am thinking of the object.” The VVIQ is commonly used to identify people with aphantasia. In this study, those

with an average VVIQ score of less than 2 were considered aphantasic, those with a VVIQ score of 2 to 3 were considered typical imagers, and those with a VVIQ score of 5 were considered hyperphantasics.

The 8-item Patient Health Questionnaire (PHQ-8) was used as a measure of depression. The PHQ-8 is a modified version of the PHQ-9 (Kroenke et al., 2001) which only excludes one question relating to suicidal ideation and self harm. Both have been established as valid diagnostic measures of major depressive disorders based on the DSM-IV and have been used in many studies involving clinical populations. The PHQ-8 asks participants “over the last two weeks, how often have you been bothered by the following problems” such as “little interest or pleasure in doing things” or “feeling down, depressed, or hopeless.” They respond using a four-point scale from “not at all” to “nearly every day.” Scores range from 0 to 24 and a score of 10 or higher is considered to be a clinically significant level of depression. This questionnaire was given to participants on the Qualtrics survey.

The 7-item Generalized Anxiety Disorder assessment (GAD-7; Spitzer et al., 2006) was used as a measure of anxiety. Participants responded to this questionnaire on the Qualtrics survey. The GAD-7 has been established as a valid self report measure of anxiety in the general population (Löwe et al., 2008). Similarly to the PHQ-8, it asks participants “over the last two weeks, how often have you been bothered by the following problems,” such as “feeling nervous, anxious, or on edge,” or “not being able to stop or control worrying.” Scores range from 0 to 21 with a score from 5 to 10 indicating mild anxiety, a score from 10 to 15 indicating moderate anxiety, and a score greater than 15 indicating severe anxiety.

Questions from the Oxford Happiness Questionnaire (OHQ; Hills & Argyle, 2002) were used to assess overall well being. Four questions from the OHQ are included in the initial

surveys on the Mind Window app. The OHQ is typically a 29 item questionnaire which asks participants how strongly they agree or disagree with statements such as “I don’t feel particularly pleased with the way I am” and “I feel that life is very rewarding” on a six-point scale. Scores range from 1 to 6 with 1 indicating that a person is “not happy” and 6 indicating that a person is “too happy.”

The 12 rumination related questions from the Rumination-Reflection Questionnaire (RRQ; Trapnell & Campbell, 1999) were used to assess rumination in participants. Participants responded to this questionnaire on the Qualtrics survey. Rumination refers to repetitive thoughts about negative or distressing feelings and situations. It may contribute to the maintenance of mental health conditions like depression and anxiety. The RRQ asks participants to rate how strongly they agree or disagree with statements like “long after an argument or disagreement is over with, my thoughts keep going back to what happened” and “my attention is often focused on aspects of myself I wish I'd stop thinking about.” on a six-point likert scale. There are three reverse scored questions and scores range from 1 to 5 with higher scores indicating higher levels of rumination.

Daily experiences of vividness were measured by a vividness question on the Mind Window app. This question is a rotating question so it would appear in approximately one in every five check-ins that a participant completes on the app. This question asks “In the moments before the notification, overall, how vivid were your thoughts in your "mind's eye?"” Participants respond on a five-point scale that ranges from “no image at all (you only "know" you are thinking of something)” to “perfectly clear and vivid as normal vision.” Vividness was averaged across all check-ins for each participant. We also looked specifically at the vividness ratings of internal or imaginative thoughts. This refers to thoughts that are self generated rather than

thoughts related to external perceptions, such as looking at an animal in front of them. This is so we can look at the vividness of things like memories and prospective thoughts rather than actual visual experiences which would likely be rated as very vivid.

The affective content of everyday thoughts was measured by an affective content question on the Mind Window app which appears in every check-in that participants complete. This question asks “in the moments just before the notification, how positive or negative were your thoughts” and responses range from “very positive” to “very negative.” Affective content was averaged across all check-ins for participants. Increased levels of negative thought may correspond to increased levels of depression or anxiety.

Analyses:

All statistical analyses were performed using JASP statistical software version 0.17.1. The threshold for statistical significance was set to $p < .05$ for all analyses. In order to test whether or not there is a relationship between aphantasia and mental imagery abilities, a Pearson’s correlation was run between the VVIQ and the PHQ-8 as well as the between the VVIQ and the GAD-7. We also wanted to test if vividness in everyday thoughts may be a better predictor of depression or anxiety compared to a one time questionnaire like the VVIQ, so we ran Pearson’s correlations between the vividness check-in question averages and the PHQ-8 and the vividness check-in and the GAD-7. The same correlations were run for the vividness of imaginative thoughts only.

We also wanted to look at whether or not people with decreased imagery abilities have higher or lower levels of well-being compared to people with typical or high mental imagery abilities. Thus, Pearson’s correlations between the VVIQ and the OHQ as well as between the vividness check-in total and the OHQ, and the vividness of imaginative thoughts and the OHQ.

We also wanted to look at whether or not vividness of thought is associated with having more positive or negative thoughts as this could be associated with depression or anxiety. Pearson's correlations were run between the affective content Mind Window check-in question with the VVIQ as well as with the vividness of thought Mind Window question, and the vividness of imaginative thoughts only.

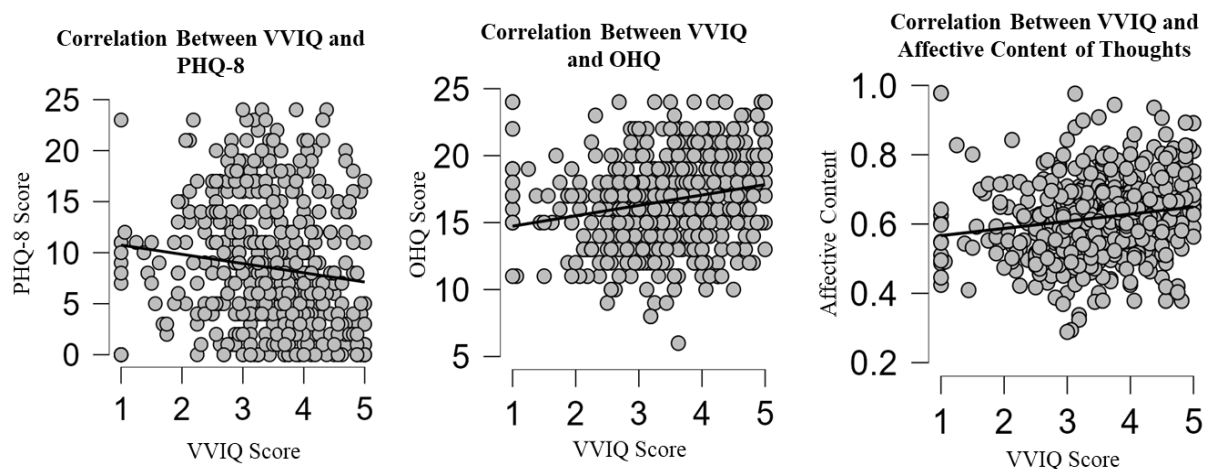
We also wanted to test whether aphantasia or decreased imagery abilities are associated with increased levels of rumination and whether less vivid thoughts in general are more likely to be ruminative. A Pearson's correlation was run between the RRQ rumination scale and the VVIQ, the RRQ and the vividness check-in total, and the RRQ and the vividness of imaginative thoughts.

Lastly, we wanted to see if aphantasics who scored low on the VVIQ who have higher levels of depressive or anxious symptoms according to the PHQ-8 and GAD-7 have a higher or lower overall level of well being. This was tested using a two way analysis of variance with VVIQ and PHQ-8 scores as independent variables and the OHQ as the dependent variable. A second was done with the GAD-7 in place of the PHQ-8.

Results

Pearson's correlations were calculated to look at the relationship between VVIQ scores and levels of depression and anxiety as well as well-being. A significant negative correlation was found between VVIQ score and PHQ-8 scores (depression), $r(482) = -.13, p = .005$. There was no significant correlation between the VVIQ and the GAD-7 (anxiety). VVIQ scores were positively correlated with the OHQ measure of well-being, $r(512) = .20, p < .001$.

Figure 1
Significant Correlations with the VVIQ



Pearson's correlations were also computed to assess the relationship between the vividness of everyday thoughts via the vividness Mind Window question and depression and anxiety levels. Similarly to the VVIQ, there was a negative correlation between the vividness check-in question total and the PHQ-8 (depression), $r(480) = -.15, p = .001$, however, there was no correlation with the GAD-7 (anxiety). There was a similar relationship between the vividness of imaginative thoughts with the PHQ-8, $r(406) = -.16, p < .001$. There was also a positive relationship between the vividness check-in total and the OHQ well-being scale, $r(527) = .19, p < .001$ as well as the vividness of imaginative thoughts and the OHQ, $r(447) = .21, P < .001$.

Correlations were also run for the RRQ rumination scale with the VVIQ and the everyday vividness Mind Window check-in. Rumination was not significantly correlated with any measure of vividness of mental imagery.

There was a positive correlation between VVIQ scores and the average rating of affective content of thoughts on the Mind Window app, $r(511) = .17, p < .001$. There was a stronger positive correlation between everyday vividness of all thoughts and affective content of thoughts, $r(527) = .24, p < .00$, as well as between the vividness of imaginative thoughts and affective content, $r(447) = .25, p < .001$.

Figure 2
Significant correlations with vividness of all thoughts on the Mind Window app

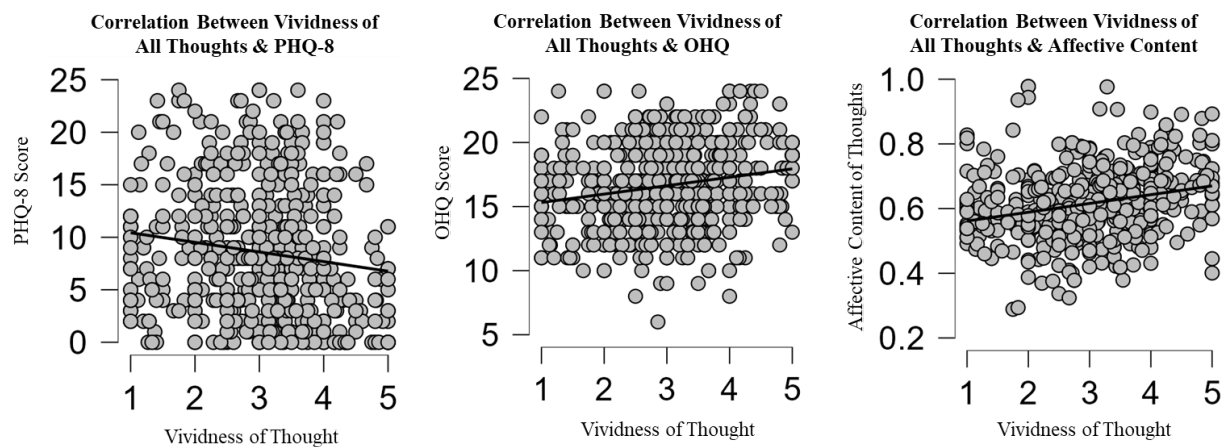
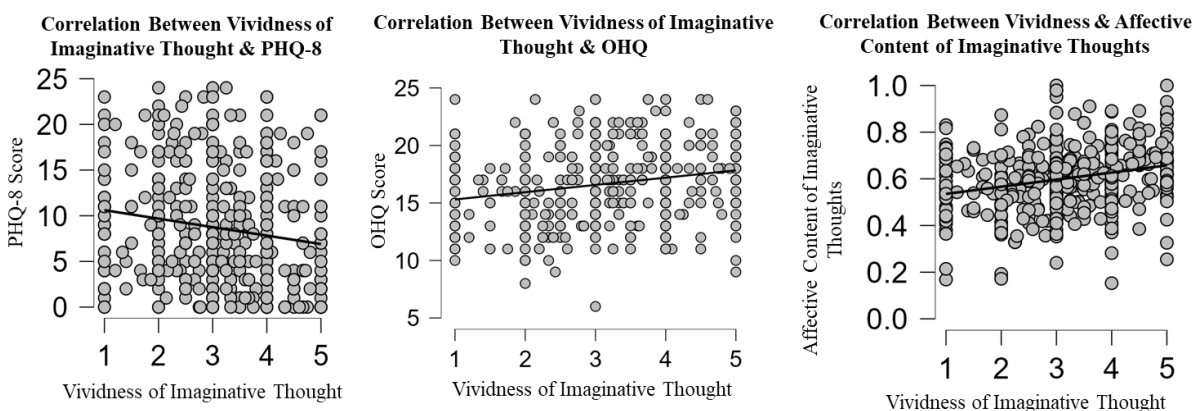


Figure 3

Significant correlations with the vividness of imaginative thoughts only from the Mind Window app



A two-way between-subjects ANOVA was computed with mental imagery status (aphantasic vs non-aphantasic) and depression level (depressed or non-depressed) as independent variables and OHQ score as the dependent variable in order to test for a difference in group means between the two conditions. This analysis was run using the sample of 32 aphantasics and 32 non-aphantasics. Test assumptions were checked and the assumption of homogeneity of variance was not violated according to Levene's test was insignificant with a p value of .820. A Q-Q plot was also used to check normality and no deviations were found. The ANOVA did not reveal a significant main effect of imagery status on OHQ score. In other words, the group of aphantasics did not significantly differ from the group of non-aphantasics in terms of well-being according to the OHQ. The ANOVA did however reveal a main effect of depression level on OHQ score, $F(1, 57) = 15.676$, $p < .001$, $\eta^2 = .215$. Those who had a PHQ-8 score of greater than 10, which is the general cutoff for clinically significant depression levels, had well-being scores that differed from those who were not depressed according to the PHQ-8. No interaction was found between mental imagery status and depression levels on well-being scores.

A similar ANOVA was run using mental imagery status (aphantasic vs non-aphantasic) and anxiety level (anxious or non-anxious) as independent variables and OHQ score as the dependent variable, however, there was no significant main effect of mental imagery status or an interaction between mental imagery and anxiety level. There was a significant main effect of anxiety on OHQ score, $F(1, 57) = 128.8$, $p < .001$, $\eta^2 = .688$.

Discussion

This paper sought to examine the role that a lack of mental imagery, or aphantasia, can play in mental health conditions including depression and anxiety. More specifically, we wanted to explore how everyday experiences of mental imagery, or a lack thereof, can affect the prevalence of anxiety and depression or affect the ways in which these conditions can manifest themselves in different people. Based on our analyses, it appears that there may be a link between aphantasia or decreased mental imagery abilities and depression. Increased levels of depression were correlated with lower levels of mental imagery. This appeared to be true based on both a one time questionnaire (the VVIQ), and everyday experiences of imagery (the vividness Mind Window question). People who scored lower on the VVIQ tended to score slightly higher on the PHQ-8 depression scale and people who on average experienced less vivid thoughts from day to day (across all thoughts on the Mind Window app and specifically imaginative thoughts) also scored higher on the VVIQ. This result differs from what we hypothesized because we initially expected that aphantasia may provide some protection from depressive symptoms due to the inability to form vivid intrusive mental imagery. We also initially expected that if aphantasics did experience higher levels of depression, then it may be due to higher levels of rumination, or repetitive, maladaptive thinking. However, our results do not suggest that aphantasia is associated with increased levels of rumination, so there must be other factors. People with aphantasia may be less prone to negative intrusive imagery, however, they may also experience less positive mental imagery. There is evidence that suggests that positive prospective imagery can improve and prevent depressive symptoms, and since people with aphantasia lack mental imagery, they may not experience the benefits of positive imagery. They can imagine positive future scenarios and past events, however, they may not be able to do

so as vividly, and these scenarios may not evoke positive emotions as strongly as memories or thoughts comprised of vivid mental imagery. Additionally, one notable feature of depression is a lack of specificity of autobiographical memories (Dalgleish, & Werner-Seidler, 2014).

Overgeneralized memories have been shown to contribute to the maintenance of depressive symptoms. Since people with aphantasia may recall autobiographical memories in less detail due to the lack of mental imagery, this could increase their vulnerability to depression as well as allow existing depressive symptoms to persist.

However, there does not appear to be a clear relationship between aphantasia and anxiety. Lower imagery levels were not correlated with higher or lower levels of anxiety. We initially expected that both anxiety and depression would be affected by aphantasia, however, based on this data, it appears that only depression is. The literature suggests that negative mental imagery can promote feelings of anxiety, however the role of mental imagery in anxiety is not as clearly established as in other conditions like depression or PTSD.

Lower VVIQ scores and less vividness in everyday thought were also correlated with slightly lower levels of well-being according to the Oxford Happiness Questionnaire. This could also be due to less vivid positive imagery. A lack of mental imagery could attenuate the emotional amplification of positive thoughts and positive imagery.

This study however, does have some limitations, particularly in regards to the sample. Although most of the analyses were performed using a large sample of over 500 people, this sample may not be very generalizable to the population. This study is primarily comprised of college students from the University of Arizona, most of which are studying psychology. It also involved a much greater number of females compared to males which could have affected results in that women tend to experience depression and anxiety at higher rates than men. It was also a

primarily White sample. There were also only 32 people in this study who were classified as aphantasics. The prevalence of aphantasia is only around 4%, so this makes sense, however, it does make it a challenging population to study.

Although there is a great deal of data from the SONA study and Mind Window app, the data pertaining to aphantasia, depression, and anxiety are somewhat limiting. In the future, it would be very useful to use the Mind Window app in conjunction with an in person study within the lab in order to learn more about people with aphantasia and how their experiences might differ compared to most other people. For this study, we also averaged all data from the Mind Window check-ins, so it would be interesting to look at the data over time, or look in more detail at the characteristics of specific kinds of thought. For example, it would be interesting to look specifically at positive or negative thoughts in order to find patterns. Another future direction could be to look at the relationship between aphantasia and other conditions involving mental imagery such as PTSD or to look more into how treatments may need to be more individualized for people with lower imagery abilities.

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