

The relationship between multilingualism and visual imagery: Investigating aphantasia using the VVIQ

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SUMMARY

The ability to generate vivid mental images plays a crucial role in cognitive and creative processes in a modern, visually-driven world. Visual imagery abilities contribute to problem-solving, memory retention, and artistic expression. However, some people lack visual imagery ability, a condition called aphantasia. The Vividness of Visual Imagery Questionnaire (VVIQ) is designed to test visual imagery ability by self-reporting and prompting individuals to have mental images in their minds. Although numerous studies have investigated the interactions between aphantasia and various cognitive capacities, such as memory, learning, and neurological disorders, little research exists on the correlation between linguistics and visual imagery. This study aimed to investigate whether a positive correlation exists between multilingualism and visual imagery ability, hypothesizing that fluency in multiple languages enhances visual imagery skills, thereby reducing the likelihood of aphantasia. We tested this hypothesis on a group of 302 participants who completed the VVIQ. Our results indicate that speaking more languages correlates with higher VVIQ scores, suggesting that multilingualism may enhance visual imagery ability and reduce susceptibility to aphantasia. Further research that controls for variables such as age and gender is necessary to better understand the association between multilingualism and visual imagery ability.

INTRODUCTION

Aphantasia is a condition characterized by the inability to generate visual imagery in their minds, often referred to as the lack of a 'mind's eye.' Unlike most people, who can imagine scenes, objects, or faces, individuals with aphantasia (aphantasics) cannot form these mental images. This condition affects approximately 3.9% of the population (1). Research indicates that while aphantasics can describe objects and ideas verbally, they cannot generate mental images to accompany their thoughts. This inability to visualize can impact various aspects of life where mental imagery plays a role, such as memory and learning. Despite the challenges associated with aphantasia, those affected come from diverse backgrounds and professions, which indicates that it does not necessarily hinder professional or personal success (2).

While aphantasia, as a condition, has only recently been formally named, its history dates back to the late 19th century, when scientists first began to observe differences in

individuals' ability to visualize. Francis Galton observed that some individuals were better at visualizing objects in their minds than others (3). However, it was not until 2003 that Adam Zeman published the initial case report on aphantasia (4). This occurred after he encountered a 65-year-old patient who, following heart surgery, lost the ability to mentally visualize familiar people and places (5). Aphantasia can take two forms: congenital and acquired. Congenital aphantasia is present from birth, and those affected may not realize that their lack of mental imagery is unusual; it may have a genetic basis (6). In contrast, acquired aphantasia develops later in life, often due to an injury, illness, or mental health conditions (7).

While it is not classified as a mental illness or disorder, some studies have explored the association between aphantasia and conditions like autism due to their overlapping traits such as impaired social skills and reduced imagination (2). Aphantasia's impact on memory varies, with some individuals reporting difficulty recalling specific visual details of past events (2). This raises broader questions about the relationship between cognitive abilities and the brain's plasticity. Given the potential connections between aphantasia and cognitive traits, this study also explores the role of multilingualism in visual imagery. Linguistic skills, particularly in bilingual individuals, are known to significantly enhance cognitive functions through improved executive control, including attention management, problem-solving, and task switching. The need to navigate between languages trains the brain to resolve conflicts and focus better, which leads to better performance on cognitive tasks. As a result, brain plasticity is also promoted, which enables the brain to adapt and reorganize itself in response to the demands of bilingualism, ultimately boosting overall cognitive functions (8). This may, in turn, reduce the chances of developing non-congenital aphantasia.

Despite extensive research on aphantasia and its cognitive implications, the direct relationship between multilingualism and visual imagery remains underexplored. This gap in knowledge limits our understanding of how linguistic abilities may influence mental imagery and the potential cognitive benefits of multilingualism for individuals with aphantasia. In this study, we aimed to investigate whether a positive correlation exists between multilingualism and visual imagery ability. We hypothesized that fluency in multiple languages enhances visual imagery skills, thereby reducing the likelihood of aphantasia. By exploring this relationship, we sought to address a gap in the literature regarding the cognitive and linguistic factors that may influence visual imagery and aphantasia. Our findings may offer new insights into supporting individuals with aphantasia in educational

and professional settings, as well as highlight the potential cognitive benefits of multilingualism for enhancing mental imagery.

To measure visual imagery ability, we used the Vividness of Visual Imagery Questionnaire (VVIQ), a widely used self-reporting tool developed by David Marks in 1973 that measures the vividness with which individuals can see scenes, people, and objects in their imagination (9, 10). The VVIQ consists of 16 items scored on a 5-point scale ranging from 16 to 80 points. In most circumstances, a score from 16 to 32 indicates extremely low levels of visual imagery and the onset of aphantasia, 33 to 59 indicates low visualizers, and 60 to 80 indicates high visualizers (11). Individuals scoring 16-32 are considered to have aphantasia, while those scoring 33-59 may have varying levels of reduced visual imagery, implicating some form of aphantasia (12). Studies such as Friedlander et al.'s examination of visual imagery and creativity, Bainbridge et al.'s exploration of visual imagery in relation to object and spatial memory, and Liu et Bartolomeo's investigation into the impact of aphantasia on visual perception using VVIQ demonstrate this method's reliability and versatility (13 - 15). Beyond self-reporting tools like the VVIQ, neuroimaging techniques such as Functional Magnetic Resonance Imaging (fMRI) scans have been used to explore the neural basis of aphantasia, providing complementary insights into the condition. fMRI studies reveal distinct patterns of brain activity in aphantasics compared to individuals with typical visual imagery, particularly in regions associated with visual processing and mental imagery (16). These findings provide valuable insights into the biological mechanisms underlying aphantasia, complementing the subjective data gathered through questionnaires like the VVIQ. However, due to the accessibility and practicality of self-reporting tools, the VVIQ remains the most widely used method for identifying and studying aphantasia in large populations.

We distributed the VVIQ questionnaire along with background questions to 521 participants recruited from southwestern Canada, aged 16 to 18. This group of participants speaks a varying number of languages, and we specifically asked about the languages they are fluent in to ensure all participants reported languages at the same level of fluency, thereby eliminating this variable as a factor that could potentially affect the results. We hypothesized that fluency in a greater number of languages is negatively correlated with the likelihood of having aphantasia. Our results demonstrate a significant positive correlation between multilingualism and visual imagery ability, with multilingual participants exhibiting higher VVIQ scores than monolinguals. These findings suggest that language fluency may enhance cognitive processes underlying mental imagery, potentially reducing susceptibility to aphantasia. Future research should explore additional variables such as age of language acquisition and neurological markers to further elucidate this relationship, while expanding demographic diversity to strengthen generalizability.

RESULTS

To examine the potential correlation between the number of fluent languages spoken and the visual imagery ability, we distributed a survey containing the VVIQ and background questions to 521 students in schools in southwestern Canada. Out of the 521 students, a total of 302 students completed this

survey (completion rate 58.0%). Language fluency distribution showed that 206 participants (68.2%) were monolingual, 80 (26.5%) were bilingual, 12 (4.0%) were trilingual, 3 (1.0%) were quadrilingual, and 1 (0.3%) was fluent in five languages (**Table 1**). Regarding specific language fluency among all participants (including multilingual individuals), English was the most common language (299 participants, 99.0%). Other reported languages included: Mandarin (46 participants, 15.2%), French (25, 8.3%), Cantonese (23, 7.6%), Korean (7, 2.3%), Japanese and Spanish (6 each, 2.0%), German (4, 1.3%), Vietnamese (2, 0.7%), and Russian (1, 0.3%) (**Table 2**). Among respondents, 10 (3.3%) scored ≤ 32 on the VVIQ, aligning with the general population prevalence of aphantasia (2). Notably, 80% of these low scorers were monolingual, and none spoke more than two languages.

Based on the number of fluent languages the respondents spoke, they were sorted into different groups and their scores of VVIQ were calculated. Mean VVIQ scores increased with the number of fluent languages spoken (**Figure 1**). Monolingual respondents had the lowest mean score ($M = 49.4$, $SD = 16.7$), while individuals fluent in two languages had a higher mean score ($M = 57.0$, $SD = 13.9$). This trend continued with participants fluent in three ($M = 60.0$, $SD = 12.9$), four ($M = 63.0$, $SD = 11.5$), and five languages ($M = 69.0$, $SD = 10.0$).

There was a statistically significant difference between VVIQ scores of monolingual and multilingual respondents ($t(300) = 4.73$, $p < 0.001$), with a moderate effect size (Cohen's $d = 0.64$). We also saw that there was a significant effect of the number of languages spoken on VVIQ scores ($F(4,297) = 3.13$, $p = 0.015$). Post-hoc analysis further indicated that multilingual participants consistently exhibited higher VVIQ scores. Finally, a linear regression analysis yielded a strong and statistically significant relationship ($t(296) = 96.84$, $p < 0.001$) with an R^2 value of 0.969, indicating that the number of fluent languages explained 96.9% of the variance in VVIQ scores. The data showed a significant positive correlation between the number of fluent languages spoken and VVIQ scores. Participants fluent in more languages had higher mean VVIQ scores.

DISCUSSION

Our data provides strong evidence that increased language fluency is associated with improved visual imagery ability, supporting the hypothesis that multilingual individuals are less likely to experience aphantasia. The findings demonstrate a significant positive correlation between the number of fluent languages spoken and visual imagery abilities, as measured by the VVIQ. Statistical analyses, including one-way ANOVA and linear regression, revealed that the number of fluent languages spoken explains nearly 97% of the variance in VVIQ scores ($p < 0.001$), indicating a strong and meaningful relationship. These results suggest that individuals fluent in more languages tend to have higher VVIQ scores, reflecting stronger visual imagery abilities.

To further explore this relationship, we analyzed the 10 respondents with VVIQ scores ≤ 32 , representing approximately 3.3% of the sample. Among these individuals, 80% were monolingual, and none were fluent in more than two languages. This distribution suggests that monolingualism may contribute to lower visual imagery abilities, whereas multilingualism might act as a protective factor against

Number of Fluent Languages Spoken	Number of Respondents	Percentage of Respondents
1	206	68.2%
2	80	26.5%
3	12	4.0%
4	3	1.0%
5	1	0.3%

Table 1. Student survey respondents by number of fluent languages spoken. Number and percentage of respondents based on their number of fluent languages spoken.

aphantasia. These findings align with prior research on the cognitive benefits of multilingualism, such as enhanced executive control and cognitive flexibility (18, 19). The constant need to switch between languages and resolve linguistic conflicts could enhance the brain's ability to generate and maintain vivid mental images, potentially reducing the likelihood of aphantasia. This suggests that multilingualism not only enriches cognitive functions but may also serve as a buffer against conditions where visual imagery is impaired.

The observed linear increase in VVIQ scores with the number of fluent languages underscores the potential role of multilingualism in enhancing cognitive processes. Participants fluent in only one language had the lowest mean score ($M=49.4$), while those fluent in five languages had the highest ($M=69.0$). These results suggest that engaging in complex linguistic activities, such as code-switching and semantic judging, may strengthen mental imagery abilities (17). Prior research indicates that mental imagery is often activated during language processing, such as metaphor comprehension, and is influenced by the linguistic demands of multilingualism (20, 21). The constant mental shifting between languages may train the brain to create and manipulate mental images more effectively, as seen in studies where multilingual individuals exhibit enhanced cognitive flexibility and visual-spatial processing (19). Additionally, the sensory-spatial basis of symbolic thinking in multilingual individuals further supports the idea that linguistic competence enhances mental imagery (22). Thus, multilingualism stimulates cognitive processes that may enhance visual imagery, potentially reducing susceptibility to aphantasia.

These findings have important implications for education and therapy, particularly for individuals with aphantasia or those engaged in learning multiple languages. In educational settings, language learning programs could incorporate activities that enhance visual imagery, such as visualization exercises or multisensory language tasks. For example, students could be encouraged to mentally visualize scenes or objects described in a foreign language, which may strengthen their ability to generate and manipulate mental images. Additionally, educators could explore the use of bilingual or multilingual instruction to promote cognitive flexibility and visual-spatial skills, particularly in subjects like mathematics and science, where mental imagery plays a critical role.

For individuals with aphantasia, therapeutic interventions could leverage language-based exercises to improve mental imagery. For instance, language therapy programs might include tasks that require participants to describe or imagine

Fluent Language	Number of Respondents	Percentage of Respondents
English	299	99.0%
Mandarin	46	15.2%
French	25	8.3%
Cantonese	23	7.6%
Korean	7	2.3%
Japanese	6	2.0%
Vietnamese	2	0.7%
Russian	1	0.3%
German	4	1.3%
Spanish	6	2.0%

Table 2. Student survey responses by fluent languages. Number and percentage of respondents broken down by languages each participant is fluent in.

scenarios in multiple languages, thereby stimulating the neural networks involved in visual imagery, such as resting-state functional connectivity (rsFC) within and between visuo-motor and language areas (23). Such interventions could be particularly beneficial for individuals with acquired aphantasia, where the brain's plasticity may allow for the recovery or enhancement of visual imagery abilities. Future research could explore the effectiveness of these strategies in both educational and clinical settings, providing evidence-based approaches to support individuals with aphantasia or those seeking to improve their visual imagery skills.

Our study has limitations that should be addressed in future research to improve the research accuracy. The self-reported language proficiency method did not involve formal assessments, introducing potential variability. Future studies could address this limitation by incorporating standardized language proficiency tests. Furthermore, the small sample size of participants fluent in three or more languages may limit the generalizability of findings. The focus on a specific age group (16 – 18 years old) from southwestern Canada may also restrict the applicability of results to broader populations. Future research should incorporate standardized fluency measures and a more diverse demographic sample while controlling for variables such as socio-economic background, age, and gender to validate these findings.

This research concludes that there is a positive correlation between the number of fluent languages spoken and visual imagery abilities, suggesting that greater linguistic proficiency correlates with reduced susceptibility to aphantasia. Furthermore, this research explores in-depth the potential cognitive benefits of multilingualism in enhancing visual cognitive processes. Future research could delve deeper into additional variables such as age and gender to further elucidate these connections, potentially informing educational strategies and therapeutic interventions aimed at optimizing cognitive functioning in individuals affected by aphantasia's related conditions.

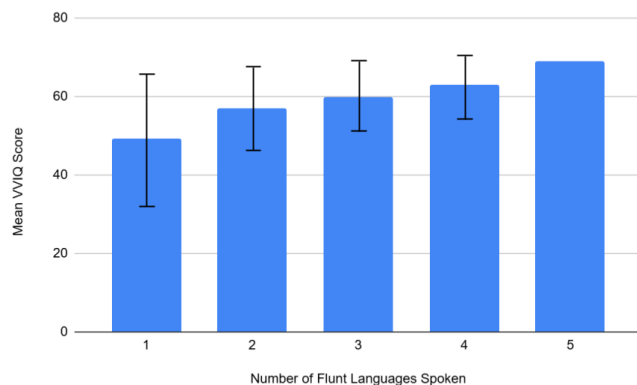


Figure 1. Vividness of Visual Imagery Questionnaire scores. Scores shown based on number of languages spoken by each respondent: one language $n = 206$, two languages $n = 80$, three languages $n = 12$, four languages $n = 3$, five languages $n = 1$. Linear regression showed that the number of languages spoken significantly predicted VVIQ scores ($R^2 = 0.969$, $p < 0.001$), demonstrating that each additional fluent language is associated with substantially improved visual imagery capability. Error bars show as mean \pm SD for each group.

MATERIALS AND METHODS

Our research was conducted between May 2024 and late June 2024. Our study was approved by the Scientific Review Committee (SRC) consisting of a licensed medical doctor, educator, and school administrator. One survey with embedded informed consent statements was made using Google Forms (see Appendix for full survey instrument). The survey was later sent to students located in southwestern Canada via social media platforms (e.g., Instagram, Discord). Statistical analyses included independent t-tests to compare monolingual and multilingual groups, one-way ANOVA to evaluate the effect of the number of languages spoken on VVIQ scores, and linear regression to determine the strength of the correlation between language fluency and visual imagery ability. All statistical tests were conducted using Google Sheets, with a significance threshold of $p < 0.05$.

To assess statistical relationships, the number of fluent languages spoken was counted, and respondents' VVIQ scores were calculated by summing the points scored on each question. Participants were grouped based on the number of fluent languages spoken, and the mean VVIQ score for each group was calculated. The mean VVIQ scores were then analyzed and converted into graphs using Google Sheets. A trendline with an R^2 value was illustrated in the graph to better show the linear relationship between the two factors.

The score gained on the VVIQ quantifies the vividness and clarity of one's mental imagery. Higher VVIQ scores indicate more vivid visual imagery abilities, whereas lower scores suggest weaker visual imagery and a higher likelihood of aphasia. To ensure consistency, participants were asked to self-report languages in which they considered themselves fluent.

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APPENDIX

Informed Consent: This is a study being conducted by Youlan Li from St. Michaels University School. This study is designed to analyze the number of fluent languages spoken and the visual imagery ability of students located in southwestern Canada aged from 16 to 18.

By completing the survey, each participant acknowledged they have read the statement on informed consent and give their consent. All responses on Google Forms are set to be anonymous and all information will be kept confidential. The data will be used only for academic purposes.

Survey:

This questionnaire is divided into 2 parts: Vividness of Visual Imagery Questionnaire (VVIQ) questions and background questions. Please report accurately and based on your actual personal background. Thank you for filling out this questionnaire.

VVIQ, the Vividness of Visual Imagery Questionnaire, explores the vividness of your visual imagination. It was created in 1973 by British psychologist David Marks and is proven to be an accurate test of the vividness with which you can see people, objects, or settings in your mind's eye.

VVIQ Instructions:

For each scenario, try to form a mental picture of the people, objects, or setting. Rate how vivid the image is using the 5-point scale. If you do not have a visual image, rate vividness as "1". Only use '5' for images that are lively and vivid as real seeing. The rating scale is as follows:

1. No image at all, I only "know" I am thinking of the object
2. Dim and vague image
3. Moderately realistic and vivid
4. Realistic and reasonably vivid
5. Perfectly realistic, as vivid as real seeing

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

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

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

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

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

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

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

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

Thank you for completing the VVIQ section. Now, here are a few personal background questions for you to answer.

Number of Languages you are Fluent In (Please fill out a number):

What Languages Specifically Are You Fluent At:

Age: