Chapter 57

Imagination capacity in university students: aphantasia and its possible changes in personal development

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ABSTRACT

This research is about Aphantasia, a condition in which the individual has his or her imagination capacity diminished or absent, and which can be acquired or congenital. This study aims to analyze the percentage of university individuals with aphantasia, within the three areas of knowledge (Human, Exact and Biological) and compare this percentage, within the university environment, with the percentage of aphantasia in the general population, which has already been estimated around 2% by researcher Adam Zeman. The study is of the cross-sectional observational type conducted with university students. Data collection will be performed from the Vividness of Visual Imagery Questionnaire (VVIQ), sent digitally and completed by participants by Google Forms. The collected data will be processed and analyzed in Microsoft Excel. As a result of the research it is expected to be able to analyze whether the percentage found of people with aphantasia in the university population is the same as that found in the general population. In a way, the expectation that is assumed is that the percentage of aphantasia found in the university environment is lower than the percentage found in the population, since the capacity for imagination and abstraction are useful instruments and facilitators of learning and construction of knowledge, both practical and abstract and that its absence can be a difficulty to enter the undergraduate course. From this, we will raise arguments, hypotheses and discussions about the data collected, addressing possible causes and consequences for it in the academic-educational environment and in personal development.

Keywords: imagination, visual perception, eidetic image, magnetic resonance imaging, cognition, students

1 INTRODUCTION

Imagination can be understood as the ability that allows us to travel between space, time, dimensions, realities and objects, accessing sensory and sentimental experiences. [1] Aristotle defined imagination as the virtue of which we say that an image occurs to us. [2] It is considered an essential capacity of human and even everyday experience. [2][3] Many researchers see it as one of the capabilities that differentiate us from other animals, being a definer of human cognition and certainly one of the most remarkable products of evolution. [1] However, for some individuals, mental visualization capacity is absent. Imagination, therefore, is restricted, limited. This condition is called Aphantasia. [4][5]

Aphantasia is a condition in which an individual has decreased or absent voluntary imagination capacity. This condition can be congenital or acquired, both due to physiological and psychopathological causes and it is estimated that approximately 2% of the normal population has this condition. [4][5][6] The term "Aphantasia" (from Greek: A - denial; phantasia - imagination) was coined by researcher Adam Zeman in 2010 to describe this phenomenon reported by his 65-year-old mx patient, who had abruptly lost the ability to invoke images with his "eye of the mind" after undergoing cardiac surgery. Even his dreams became ablind. [4][5]

Zeman, after this particular case, began to detect reports from other people who identified themselves with the same condition of absence of imagination. However, their deficiencies were lifelong,

that is, congenital. [4] From this, a questionnaire was applied so that the degree of imagination of these individuals could be evaluated, compared to a control group of "normal" people. [4]

The inability to evoke images with the mind is not something recent. Reviewing the literature are previous studies that had already reported this phenomenon with other names, which, however, have gone unnoticed over the years. The first researcher to report this condition was Dalton in 1880 with his study entitled "breakfast table research". [4][6] Dalton describes people who claimed to have no imagination power. Other studies that corroborate these reports are: the case of Charcot and Bernard made in 1883, which describes the case of Monsieur X with sudden loss of the ability to construct mental images after a brain injury; and the case of Magellan and Lemos made in 1906, which describes a patient who suffered from recurrent hysterical crises. [6][7] In addition to these examples, the literature also points out several other factors that end up altering the vivacity of mental images, such as depression, anxiety, depersonalization and use of some medications. [6][7] These cases illustrate the etiological diversity of Aphantasia, expanding the research area for this condition. [4][6][7]

Although the ability to imagine is subjective, particular and varies greatly between individuals, it is possible to quantify it and establish a pattern of "normality". In 1973, researcher David F. Marks developed the Vividness of Visual Imagery Questionnaire (VVIQ) for this purpose. [8] With this instrument it is possible to identify people with very high imaginative abilities (e.g. people with synesthesia) and those with reduced imagination (aphantasia). [4] This same questionnaire was adapted by Zeman and applied to his volunteers who reported absence of imagination. Its extremely interesting results brought quantitative confirmations of this condition that had hitherto been little explored. [4][7]

Following Zeman's research published in 2015, Jon Fulford conducted another study, based on MX patient analyses, to investigate the brain areas that modulate the degree of vividness of images in individuals. [5] To do this, he selected some participants according to their scores in the adapted VVIQ questionnaire. From this, he performed Magnetic Resonance Imaging (fMRI) on the participants to examine brain activation as they looked at images of famous faces and later imagined these faces. [5] Participants who had low grades in the VVIQ, that is, low liveliness, presented, in general, diffuse activation and in more brain regions than the group of participants who had high scores in the VVIQ, that is, high liveliness. [5] However, some more restricted areas were more activated in participants with high liveliness than in participants with low liveliness. [5] The brain of high-lived individuals was activated more selectively. **In a way, this data is in line with evidence that proficiency in larger tasks tends to be associated with reduced brain activation and that higher imaginary performance is associated with the activation of more restricted areas, because even the deliberate visualization of simple things requires several basic cognitive functions.** [5] Neurocognitive studies of the imagination point to three main components: executive processes (responsible for selecting, initiating, maintaining and monitoring visualization), memory processes (responsible for providing information about the item to be viewed) and almost perceptive processes (responsible for giving the visual image its "visual" qualities). [5]

Fulford's comparative analysis also revealed the existence of brain areas that respond positively or negatively to the vividness of the images. [5] A series of posterior regions extending from the occipital lobe to the parietal and temporal present positive correlation with vivacity, while several and contrasting areas showed negative correlation, including cuneus, lower and middle occipital gyrations, precentral and inferior frontal, insula and anterior cingugulum gyrations. [5] Some areas in particular had a positive and negative standard correlation for liveliness among all participants. Regions of the parahippocampal fusiform gyres, posterior cingulates and precuneus (Brodmann areas 19, 29, 36 and 37) showed exclusively positive correlation. [5] BAs 24, 9, 44, 47 17 and 18 showed a negative correlation. [5] Many other brain areas are positively or negatively associated with the liveliness of visual images.

In summary, areas that are positively associated with vivacity are found in posterior regions of the brain, including the upper-order visual association cortices, regions of the posterior cingules and precuneus, and medial temporal lobe, while areas negatively associated with vivacity are located particularly in the frontal lobes and auditory cortexes. [5] These findings are in agreement with previous studies in this area and, mainly, with the results of patient MX, who had a hyperactivation of the right anterior cingulate cortex (BA 24) and hypoactivation of the posterior occipito-temporal cortexes. [5]

One of the explanations raised for these differences is the failure to suppress the activity of regions that can negatively interfere with vivacity (e.g., BA 41), or by consequential or compensatory activation of executive regions with the potential to boost the imaginary process (this possibility is consistent with frontal regions). [5]

Based on the literary review about Aphantasia, the present study proposes to conduct a research with university students from the three major areas of knowledge (exact, human and biological), in order to raise an epidemiological estimate of the degree of imagination of students from different areas and, from this, discuss possible causes and consequences in development, personal and academic. The relevance of this type of research consists in the fact that it is an unexplored and new field, and no studies have been done with the Brazilian population until the exact moment. In addition, identifying where there is a greater or lesser concentration of individuals with imagination disorders can help to better understand about possible immaterial restrictions existing for the exercise of certain activities. Directing our efforts to conditions previously unknown or ignored opens up possibilities to understand new facts and, in the future, improve the quality of teaching and support for these people. Taking into account that the population is around 200 million, and that about 2% possibly has aphantasia, there would be more than 4 million individuals with reduced or absent imagination capacity. [4][9] It is known that abstraction is a necessary and often essential tool for the process of learning and intellectual development. Most people only perceive their disability in the degree of imagination in adolescence or adulthood through conversations or readings. [4] This leads us to believe that this condition has already influenced their academic performance and career choice, in addition to their subjective perception of life. Many discussions may stem from studies on Aphantasia, and we hope that the present study will make several questions possible.

2 JUSTIFICATION

A literature review on aphantasia shows that although the theme was first reported by Dalton, 140 years ago[4], it is still little explored in Brazil and worldwide. The importance of distinguishing areas of knowledge (biological, exact and human) with greater or lesser concentration of individuals with imagination disorders can help in understanding possible restrictions existing for the exercise of certain activities. In addition, having knowledge about conditions that were previously unknown or ignored opens up possibilities to understand new facts and, in the future, improve the quality of teaching and support for these people.

3 OBJECTIVES

3.1 GENERAL OBJECTIVE

The present work aims to epidemiologically analyze the different degrees of imagination among students from the three main areas of knowledge (Human, Exact and Biological) in the university environment, to evaluate whether there are possible discrepancies of aphantasia compared to the percentage found in the general population, based on previous studies.

3.2 SPECIFIC OBJECTIVES

- Disseminate and send through social media the digital questionnaire that will be used to collect the data of participants.
- To analyze the collected material in order to capture the incidence of the different degrees of imagination or absence of it (aphantasia) in university students from the three different areas: biological, exact and human; translated VVIQ questionnaire.
- Check the information about the observed prevalences: age, gender, color/ethnicity, religion, nationality, city and state of origin, area in which you study, undergraduate course, and compare with the score collected by the VVIQ questionnaire.
- Expand studies under conditions previously unknown or ignored in Brazil, opening possibilities to understand new facts and, in the future, improve the quality of teaching and support for these people.

4 METHOD

4.1 STUDY TYPE

This is a cross-sectional, comparative, quantitative and qualitative study in which university students from the three basic areas of knowledge (biological, exact and human) will be evaluated.

4.2 STUDY SITE

The research was carried out through a questionnaire, through the collection of online data, via digital platform - Google Forms, by the link: https://forms.gle/m2CGYmj5FS2SEzP6A - available on social

media in which several students, from different courses and from different locations in the country, obtained access to fill out.

4.3 SAMPLE SIZE AND SELECTION OF PARTICIPANTS

A total of 1,446 participants (482 from each area - human, exact and biological) who met the inclusion criteria in the research were included in the study.

Inclusion criteria:

The characteristics that allow the person to be admission as a survey participant include the following:

- People who have completed high school and are properly enrolled in higher education in Brazilian institutions.

Exclusion criteria:

The factors that prevent the participation of the research subject, due to the risk of changing the research results, are:

- People who are already attending master's, doctorate or graduate studies.
- People who have some kind of relevant cognitive limitation to answer the questionnaire.

4.4 DATA COLLECTION TOOLS

4.4.1 Questionnaires and/or scales

The questionnaire was made available for completion in digital media. The data was collected through a digital platform - Google forms, by the link: https://forms.gle/m2CGYmj5FS2SEzP6A - at the time the student finishes filling out and sending the answers to the database. The instruments used to evaluate the students were: information about the participant, the questionnaire entitled "Vividness of Visual Imagery Questionnaire" (VVIQ)[4] translated, validated and adapted and the non-mandatory questionnaire complementary to the VVIQ, translated, validated and adapted. [4] In the latter, it is optionally requested to fill in those who obtain a specific score in the VVIQ questionnaire (below 30 points), as indicated throughout the Google forms questionnaire. Not completing the optional questions does not compromise the research results, as they only complement the understanding of the condition studied.

4.4.2 Chips

The following variables were collected by the questionnaire: age, gender, color/ethnicity, religion, nationality, city and state of origin, area in which you study, undergraduate course, and the vividness of Visual Imagery Questionnaire score **from 16 to 80[4]**.

Other questions formulated by the author of the article "Lives without imagery - congenital aphantasia"[4] that are complementary, are not essential, not mandatory to answer, and do not compromise the results of the research, are present to fill out those who obtain a score in the VVIQ questionnaire below 30 points, as a way to better understand this condition.

4.5 DATA COLLECTION PROCEDURES

The research was carried out through the survey and analysis of the identification data of the participants, the questionnaire entitled Vividness of Visual Imagery Questionnaire (VVIQ) translated, adapted and validated and the questionnaire complementary to the translated, adapted and validated VVIQ. The e-mail address for the questionnaire was made available on social media to fill out the students. Thus, the application of the questionnaire does not count either with the physical presence of researchers and participants or with the support of an educational institution, and the consent term may have been waived because it is a public consultation. This exemption applies to all educational institutions in the country, with the exception of the Jundiaí Medical School, where it has direct contact with students. In this case, the authorization term was requested for the Jundiaí Medical School to approach students in person about the research. The questionnaire was still online, performed via Google forms, however, because of the existence of the possibility of conducting the research within the premises of the Faculty of Medicine of Jundiaí, fand z-it is necessary to include the authorization term for the research within the premises of the Faculty of Medicine of Jundiaí.

In the performance of this data collection, the researched in question if I compromised the non-disclosure or exposure of the results obtained by the research, other than for academic purposes, so that there was no kind of embarrassment on the part of the participants. The research does not require the participant to inform his name, which increase noror even more care for his protection. In addition, the participant, before starting the questionnaire, had to complete the Free and Informed Consent Form, showing knowledge of the research, agreeing with its terms and that it wanted to participate. At any time, during the completion of the data and the questionnaire, the participant must decide not to participate and not send his answer .

4.6 DATA PROCESSING AND ANALYSIS

The data from this research were collected through the digital platform Google forms and subsequently, tabulated in the Microsoft® Excel 2016 software that was used to generate the search database. To verify the quality and consistency of the data, each response was read and analyzed by the search exhaustively. Subsequently, they were submitted to statistical analysis in order to verify the possible correlation between aphantasia and the percentage of their appearance in the university environment compared to the percentage present in the general population shown in the literature. Descriptive analysis was used , presenting absolute frequency and percentage for qualitative variables, as well as mean and standard deviation for quantitative variables.

4.7 ETHICAL PROCEDURES

This research was carried out from the application of an electronic questionnaire via Google forms and will be made available and disseminated to participants through social media. Thus, the research falls

within a public consultation, in which access to the participant and the collection of their data was not mediated or does it depend on the help of any educational institution. Thus, the letter of authorization of the educational institutions to which the participants study is not necessary, precisely because it is a public consultation. In relation to the Faculty of Medicine of Jundiaí specifically, the collection of the data of its students obtained the support of the institution, since it must be done within its premises. In this case, the institution's letter of authorization was required.

The present study followed resolution no. 466/12 of the National Health Council of the Ministry of Health[10] and was submitted to the Research Ethics Committee of the Jundiaí School of Medicine.

The research is trat or an online data collection, with completion of questionnaire via digital media platform. Thus, the signature was online according to the document presented in the Free and Informed Consent Form. The risk to the participant was minimal, since if it is trat a public consultation, the data obtained were anonymized and the participant's name was not questioned. In addition, the participant does not see the obligation to participate in the research or to send his/her data, and may not participate throughout the questionnaire process at any time, if it appropriates it. Thus, the autonomy and freedom of the participant are tried to preserve the autonomy and freedom of the participant as much as possible. The benefits for participants were indirect, since aphantasia is a condition still little explored and he cooper or for a better understanding of this condition still little studied. In the future, with the knowledge acquired from this research, new possibilities for greater understanding of this condition may be opened, improving the quality of teaching and support for people.

5 GENERAL RESULTS

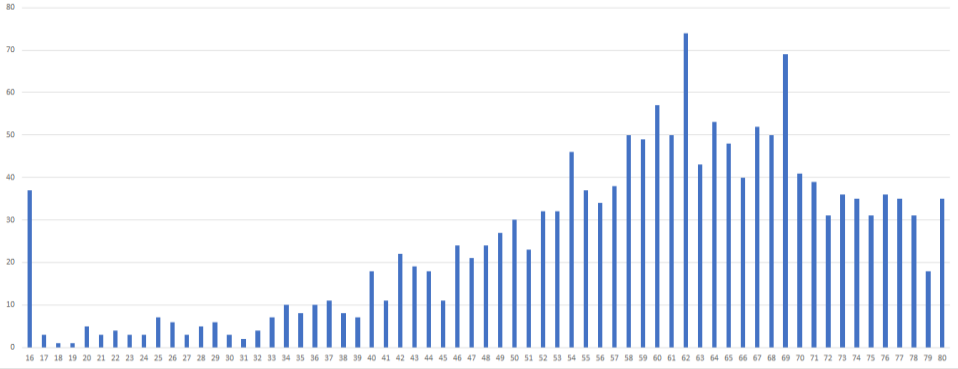
For tabulation of the data from the final report, a total of 1627 answers were selected, all analyzed and validated within the criteria previously established in the Method (Item 4). Within this total, I obtained 584 responses from the Humanities group (35.9%), 512 responses from the Exact group (31.5%) and 531 responses from the Biological group (32.6%). Thus, it exceeds the minimum amount proposed at the beginning of the survey of 482 responses from each of the 3 areas (Human, Exact and Biological) and I was able to maintain a balanced percentage between them, which contributed to the comparison and analysis that will be exposed below.

Of the participants, 1037 were female (63.7%) and 590 male (36.3%). The mean age was 20.76 years, which is an expected average within the undergraduate audience. Also in the initial parameters, color/ethnicity, nationality, city and state of origin were questioned and whether they had any religion. 1177 declared themselves white (72.3%), 293 brown (18%), 104 black (6.4%), 52 yellow (3.2%) and 1 indigenous (0.1%). Of the 1627 participants analyzed, 1623 are born in Brazil, 1 are born in Peru and 3 are born in Japan. Of those born in Brazil, 864 originated from the Southeast (53.3%), 619 from the South (38.2%), 78 from the Midwest (4.8%), 42 from the Northeast (2.6%) and 19 from the North (1.2%). The most representative states were São Paulo, with 33.7% of the total, Paraná, with 26.1% of the total, Minas

Gerais, with 9.9% of the total, Rio Grande do Sul, with 9.6% of the total, and Rio de Janeiro, with 7.6%. These 5 States together number 1,418 participants, representing 87.1% of the total. Regarding religion, 870 participants declared to have religion (54.1%), while 737 declared they had no religion (45.9%).

Within the results of the VVIQ questionnaire, i obtained an average of 58.69 points. The score ranges from 16 points (minimum score) to 80 points (maximum score). (Fig. 1) More recent research by researcher Adam Zeman redefined the scoring range that determines Aphantasia. [11] In his first article "Lives without imagery - Congenital Aphantasia" he stipulates the spectrum between 16 and 30 points to classify aphantásicos. [4] In the most recent article, "A cognitive profile of multi-sensory imagery, memory and dreaming in Aphantasia", it redefines the maximum score to classify Aphantasia as 32 points (considering the possibility of the participant scoring 2 points in all 16 questions of the VVIQ questionnaire, which fits into "dark and vague visualization" in all questions). [11] Thus, passi to use this new definition scale, in which all participants who scored between 16 and 32 points, including 32, would enter the analysis as Aphantásicos. From this, I obtained 96 participants, among the 1627 analyzed, as Aphantásicos, totaling 5.9%.

Fig. 1 - Graph representing the general distribution of the number of participants who scored each of the values of the VVIQ questionnaire. On the vertical axis is represented the number of participants and on the horizontal axis are represented the scores, which range from 16 to 80 points.



6 DISCUSSION AND CONCLUSIONS

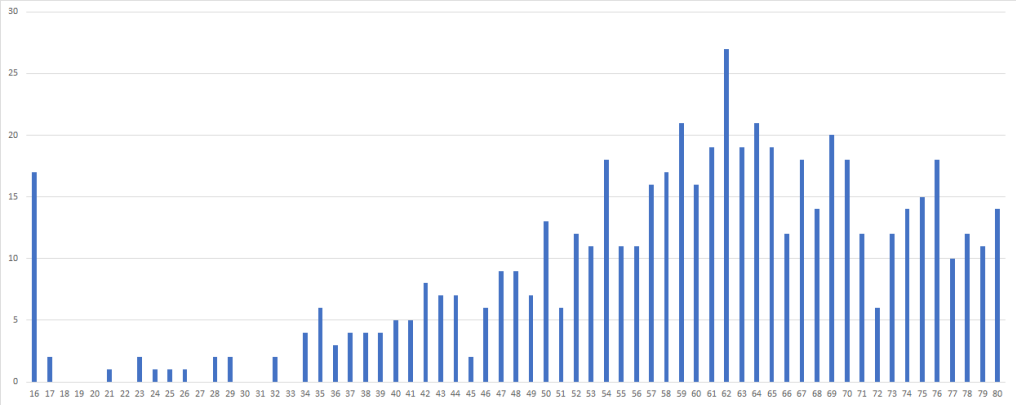
One of the first findings that surprised the data analysis was the percentage of 5.9% of Aphantásicos, because, according to the base articles, expected to find something around 2%. [4][5][6] These data will be better discussed later.

To further deepen the comparison analysis, subdivided all responses among participants belonging to the humanities, exact and biological areas to compare whether the parameters found in the global group remained in these groups separately, and also to compare the possible variations between these 3 areas. Later, I also made an analysis of the same parameters only with the group of 96 Aphantásicos, with the same intention of observing the possible differences in relation to the general result.

In the Humanities group, 408 were female (69.9%) and 176 male (30.1%). The mean age was 20.79 years. Regarding color/ethnicity, 413 declared themselves white (70.7%), 107 brown (18.3%), 53 black

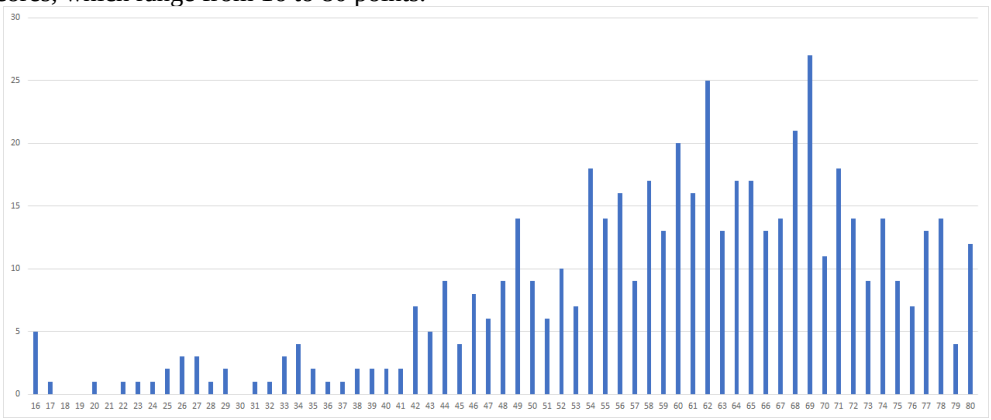
(9.1%) and 11 yellow (1.9%). Among the 584 participants, 583 were born in Brazil (99.8%) and 1 is born in Japan (0.2%). Among those born in Brazil, 300 originated from the Southeast (51.5%), 225 from the South (38.6%), 37 from the Midwest (6.3%), 13 from the Northeast (2.2%) and 8 from the North (1.4%). 295 participants declared to have religion (51.2%) and 281 declared they had no religion (48.8%). In the VVIQ questionnaire, the mean score was 59.05 points. (Fig. 2) 31 participants (5.3%) scored below 32 points, being classified as Aphantásicos.

Fig. 2 - Graph representing the distribution of the Humanities group of the number of participants who scored each of the values of the VVIQ questionnaire. On the vertical axis is represented the number of participants and on the horizontal axis are represented the scores, which range from 16 to 80 points.



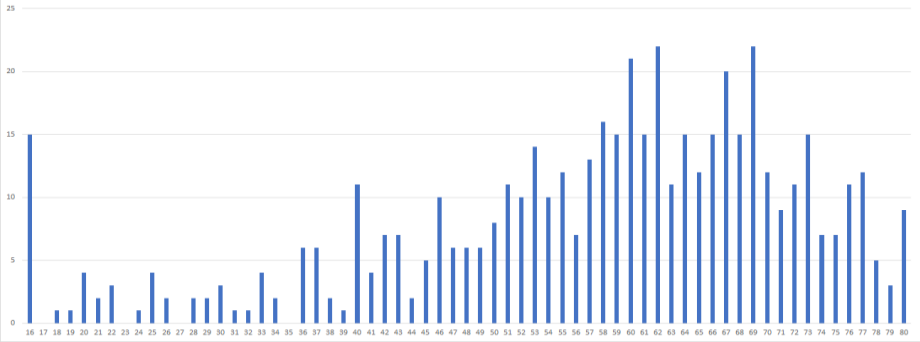
In the Biological group, 385 are female (72.5%) and 146 male (27.5%). The mean age was 21.17 years. Regarding color/ethnicity, 397 declared themselves white (74.8%), 85 brown (16%), 27 yellow (5.1%), 21 black (4%) and 1 indigenous (0.2%). Among the 531 participants, 529 are born in Brazil (99.6%), 1 is born in Peru (0.2%) and 1 is born in Japan (0.2%). Among those born in Brazil, 298 originated from the Southeast (56.3%), 198 from the South (37.4%), 14 from the Midwest (2.6%), 13 from the Northeast (2.5%) and 6 from the North (1.1%). 302 participants declared to have religion (57.3%) and 225 declared they had no religion (42.7%). In the VVIQ questionnaire, the mean score was 59.87 points. (Fig. 3) 23 participants (4.3%) scored below 32 points and were classified as Aphantasics.

Fig. 3 - Graph representing the distribution of the Biological group of the number of participants who scored each of the values of the VVIQ questionnaire. On the vertical axis is represented the number of participants and on the horizontal axis are represented the scores, which range from 16 to 80 points.



In the Exact group, 268 were male (52.3%) and 244 female (47.7%). The mean age was 20.29 years. Regarding color/ethnicity, 367 declared themselves white (71.7%), 101 brown (19.7%), 30 black (5.9%) and 14 yellow (2.7%). Among the 512 participants, 511 were born in Brazil (99.8%) and 1 is born in Japan (0.2%). Among those born in Brazil, 265 originated from the Southeast (52%), 197 from the South (38.6%), 27 from the Midwest (5.3%), 15 from the Northeast (2.9%) and 6 from the North (1.2%). 273 participants declared to have religion (54.2%) and 231 declared they had no religion (45.8%). In the VVIQ questionnaire, the mean score was 57.07 points. (Fig. 4) 42 participants (8.2%) scored below 32 points and were classified as Aphantasics.

Fig. 4 - Graph representing the distribution of the Exact group of the number of participants who scored each of the values of the VVIQ questionnaire. On the vertical axis is represented the number of participants and on the horizontal axis are represented the scores, which range from 16 to 80 points.



The mean age remained close among the 3 areas and compared to the overall result. There is a predominance of female participants in the overall result, which remained equivalent in the Biological and Human groups. In the Exact group, the highest prevalence was male participants. The South-Southeast regional axis was prevalent in all 3 areas, as well as in the general result, in the same way that the prevalence of whites is observed to the detriment of other colors/ethnicities. In all 3 areas and in the overall result, more people declared to have some religion compared to those who declared they had no religion. All these data remained consistent and similar when compared to each other.

The great differences arose when analyzing the results of the VVIQ test scores. First, as stated earlier, the overall percentage of aphantasia found was almost three times as expected. Parti of the estimate raised by the researches "Lives without imagery - Congenital aphantasia", "The neural correlates of visual imagery vividness and An fMRI study and literature review", "Refusing to imagine? On the possibility of psychogenic aphantasia. The commentary on Zeman et al. (2015)" that this condition reached around 2% of the population. [4][5][6] The light of these data is two pillars of assumptions: The first assumption is that perhaps a percentage equal to or lower would be found in the university environment and that the percentage of this condition could be different between the 3 areas (Human, Biological and Exact). Since, from previous data, it was found that most people only discovered the presence of this condition in young or adult life,[4] whetherit would analyze whether this generates any change in their individual teaching process and consequently in entering the undergraduate course. If it wereto find a percentage below 2% in

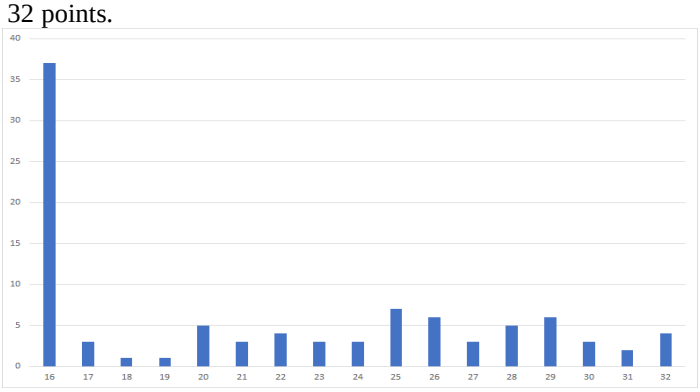
the university environment, it would be possible to raise this hypothesis in a slightly more consistent way, that there would be some kind of barrier, even if poorly understood, that could hinder the academic rise of these individuals. The second assumption, also made by other researchers previously,(2) was that if some types of careers and university courses attract more people with higher indexes of imagination (perhaps by skills requirements that the course or profession require) to the detriment of other careers and courses, in which this skill is not as important or required (which in turn attracted more people with less mental viewing capacity).

Regarding the first assumption, the data found were clearly opposed. Found 5.9% of individuals with Aphantasia in graduation. This result raises other questions that had not been taken into account so far: Is it possible that in the Brazilian population, the percentage of people with Aphantasia is greater than 2%? If it's bigger, how much bigger? The results of the present study point to this conclusion that we possibly have much more than 2% of the aphantoástica population in Brazil. Even so, these data found do not answer the initial question, if there are any barriers hindering the rise of Aphantásicos in the academic environment, since the percentage found was almost three times that expected and, therefore, it is not possible to analyze, because there is no longer a reference value of the general population for comparison. If the percentage of people with aphantasia in Brazil is greater than 2%, the data found in the university environment of 5.9% may be in the national average, as well as above or below this average. Thus, we see that the results raise more questions and open new doors for research in the future on this theme.

In relation to the second assumption, the data presented are corroborated by it. The general data reveal an average score of participants in the VVIQ questionnaire of 58.69 points and a percentage of Aphantasia of 5.9%. The data from the Biological group present an average of 59.87 points in the VVIQ questionnaire and a percentage of 4.3% of Aphantasia, showing that the level of mental visualization capacity of the participants of the Biological group, even if to a small degree, is higher than the general average, and we also observed a significant decrease in the percentage of Aphantasia present in this group compared to the overall percentage. In the Humanities group, the mean score in the VVIQ questionnaire was 59.05 points and the percentage of Aphantasia was 5.3%, following the general parameters, both in the mean of points and in the percentage of Aphantasia. The Exact group showed a result opposite to that of the Biological group. Regarding the general data, the average Score of the VVIQ questionnaire of 57.07 points presented a score of 57.07 points and the percentage of Aphantasia was 8.2%, revealing that the levels of mental visualization capacity of this group are slightly lower compared to the general average, besides having a higher concentration of individuals with Aphantasia. Such data may suggest that there is a predilection, even if unconscious, or even a greater identification with certain careers, depending on the mental visualization capacity that the individual has. Apparently, courses classified as biological courses attract people with greater mental viewing power, while courses classified as exact ings attract more individuals with lower mental viewing power, which could explain the higher concentration of individuals with Aphantasia in this area.

Subsequently, the comparative analysis of the 3 groups (Human, Biological and Exact) was made a separate analysis of individuals with Aphantasia. In this group, composed of 96 participants, 58 are female (60.4%) and 38 male (39.6%). The mean age was 20.13 years. Regarding color/ethnicity, 62 declared themselves white (64.6%), 22 brown (22.9%), 7 black (7.3%) and 5 yellow (5.2%). All 96 Aphantásicos are born in Brazil, of which 53 originate from the Southeast Region (55.2%), 32 from the South (33.3%), 6 from the Northeast Region (6.3%), 4 from the Midwest (4.2%) and 1 from the North Region. 37 declared to have religion (39.4%) and 57 declared they had no religion (60.6%). The distribution of individuals among the 3 areas was 42 in the Exact area (43.8%), 31 in the Humanities area (32.3%) and 23 in the Biological area (24%). In the VVIQ questionnaire, the mean score of this group was 21.64 points, and 37 scored a minimum score of 16 (38.5%). (Fig. 5) Excluding the average points of the VVIQ questionnaire, all other parameters remained similar to those of the general analysis, with the exception of religion. This is an interesting question because, even though it is an analysis, in a certain way, peripheral to the central point of the research, it is possible to raise the question "whether the lack of mental visualization interferes or even hinders the spiritual/religious experience of an individual", since in all groups the percentage of people who declared having religion was higher than the percentage of people who declared no religion, except in the Aphantásicos group, in which this statistic was reversed.

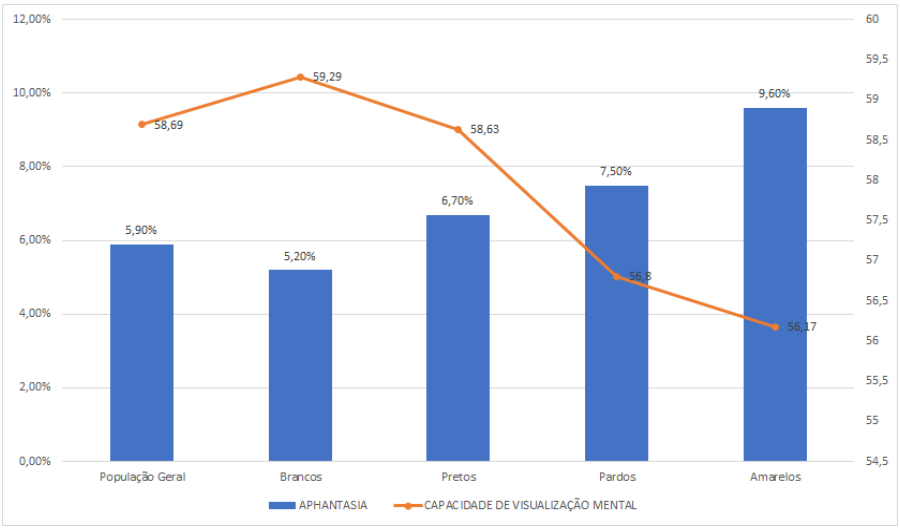
Fig. 5 - Graph representing the aphantásico group distribution of the number of participants who scored each of the values of the VVIQ questionnaire. On the vertical axis is represented the number of participants and on the horizontal axis are represented the scores, which range from 16 to 32 points.



With all these data collected, it was possible to arrive at some results: not that there is no significant or relevant difference between the mental visualization capacity based only on the individual's gender, since the mean male audience score was 58.38 points and the female audience was 58.87 points. Both very close to each other and with few variations compared to the average overall score of 58.69 points. However, a slight difference in Aphantasia was observed in relation to sex. In the group of 590 men, 38 present Aphantasia, which represents 6.44%. In the group of 1037 women, 58 have Aphantasia, representing 5.59%. However, this percentage difference is not significant to the point where a sexual predilection of this condition is noticeable, since the proportion is 1.15 Men to 1 Woman. Thus, these percentages point to the fact that Aphantasia is distributed equally among men and women.

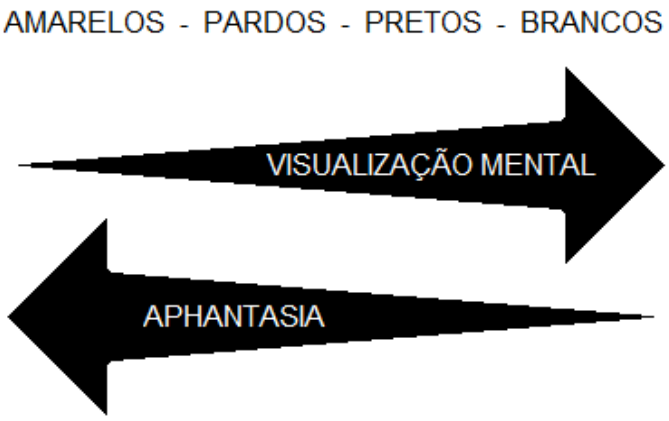
I was also able to analyze whether there is any ethnic or regional correlation linked to mental visualization capacity or Aphantasia. The white color/ethnicity, which was the most prevalent in the research, had an overall mean of points in the VVIQ questionnaire of 59.29 points, slightly above the overall survey average of 58.69 points. The color/ethnicity of the browns, the second largest participant in the survey, had an overall average of 56.80 points. Black color/ethnicity had an overall average of 58.63 points. Yellow color/ethnicity had an overall average of 56.17 points. On the other, the indigenous color/ethnicity could not establish any mean of comparison since we had only 1 representative of this group. These data show that the ethnic group with the highest mental visualization capacity was the white group, being above the general average. All other ethnic groups scored below the overall average. The second group with the highest score was the group of blacks, followed by the group of browns and, finally, the group of yellows, with the lowest score. In relation specifically to Aphantasia, there were also differences between ethnic groups. The white group, with 1177 participants, presented 62 Aphantásicos, representing 5.2%. The group of browns, with 293 participants, presented 22 Aphantásicos, which represents 7.5%. The group of blacks, with 104 participants, presented 7 Aphantasic, which represents 6.7%. The group of yellows, with 52 participants, presented 5 Aphantásicos, which represents 9.6%. With these data it is possible to observe that both the overall mean score and the percentage of aphantasics within each ethnic group follow the same proportion comparatively. The white group had the highest mean imagination of 59.29 points and the lowest percentage of aphantasic individuals, with 5.2%. The group of blacks has an average imagination of 58.63 points with 6.7% of aphantasic individuals. The group of browns has an average imagination of 56.17 points and a percentage of 7.5% of aphantasic individuals, the group of yellows has an average imagination of 56.17 points and a percentage of 9.6% of aphantasic individuals. Thus, it is possible to trace a gradation of imagination capacity among ethnic groups that is inversely proportional to the percentage of aphantasia within these groups. (Fig. 6)

Fig. 6 - Graph representing the relationship between mental visualization capacity and percentage of individuals with aphantasia in relation to ethnicities. In the horizontal axis are represented the ethnicities. In the vertical axis of the left is represented the percentage of individuals with aphantasia. The vertical axis of the right is represented the viewing capacity scored by the VVIQ questionnaire.



Thus, in view of these evidences, a possible genetic correlation for Aphantasia can be thought of, perhaps some difference that is linked to the ethnic origin of individuals, since there were significant variations both in the overall mean of mental visualization capacity among ethnic groups, and, mainly, in the percentage of aphantasia presence in these groups. However, a caveat can be raised, since the sample space of representatives of each ethnic group was not the same. It is possible that the score and percentage of Aphantasia that was obtained by each ethnic group is not so aligned with reality, but what we can attest to the data collected is that, regardless of the degree of variation between ethnic groups, it is certain that the variation exists, and it respects a proportion and equivalence, in which the greater the mental visualization capacity of a group, the lower the percentage of individuals with aphantasia it presents, while the opposite is also true, the lower the mental visualization capacity of a group, the higher the percentage of individuals with aphantasia it presents. (Fig. 6) (Fig. 7)

Fig. 7 - Representation of the inversely proportional relationship between mental visualization level and aphantasia percentage found among different ethnic groups.



In the regionalism item, some variations were also noted. The average score of practitioners originating in the Southeast region was 58.95 points, the South region was 58.56 points, the Northeast region was 55.11 points, the Midwest region was 58.29 and the North region was 60.57 points. Regarding Aphantasia, of the 864 participants from the Southeast Region, 53 present Aphantasia, which represents 6.1%. Of the 619 in the Southern Region, 32 have Aphantasia, representing 5.1%. Of the 42 in the Northeast Region, 6 have Aphantasia, which represents 14.2%. Of the 78 in the Midwest Region, 4 presented Aphantasia, representing 5.1%. Of the 19 in the Northern Region, 1 presented Aphantasia, representing 5.2%. In this regionalism item, it was not possible to draw a consistent and coherent parallel with the data already discussed above for some reasons: First, the number of individuals representing each ethnic group was not equivalent, and when the distribution of these ethnic groups among the 5 Brazilian macro regions was also analyzed. this discrepancy between the distributions and amounts of both ethnic representatives within the regions and the gross number of people from each ethnic group, it was not possible to establish a correlation between the level of mental visualization capacity and the percentage of aphantasia with the

National Macroregions. When we tried to draw the parallel between the geographical distribution of ethnicities and the degree of mental visualization capacity and Aphantasia, we obtained data that did not follow a pattern. (Fig. 8) (Fig. 9)

Fig. 8 - Graph that attempts to correlate the percentage of individuals with Aphantasia of each of the Regions with the respective mean scoring of the VVIQ questionnaire. Note that there is no pattern of correlation between them, that is, the level of mental visualization and percentage of Aphantasia do not behave interlinked.

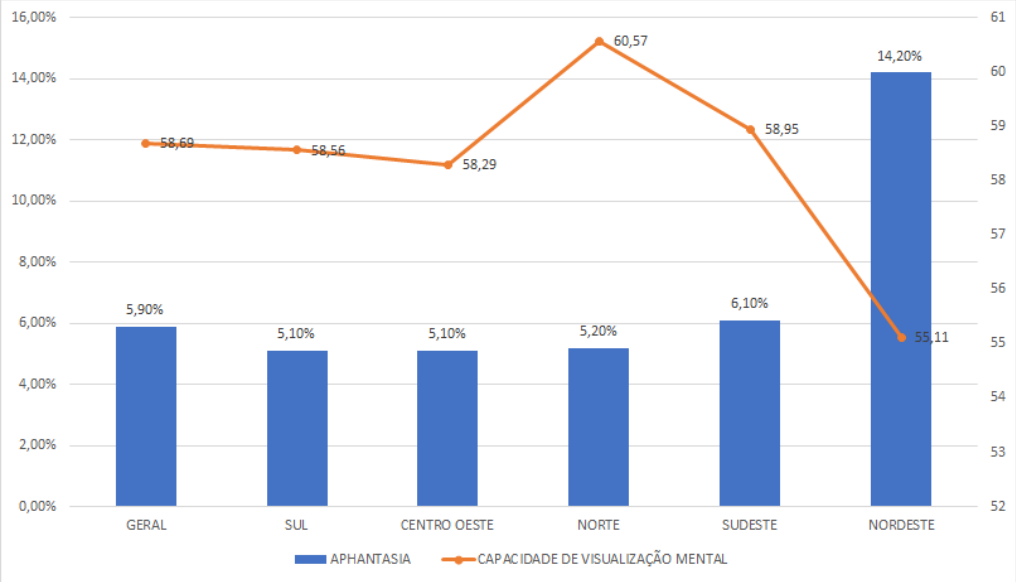
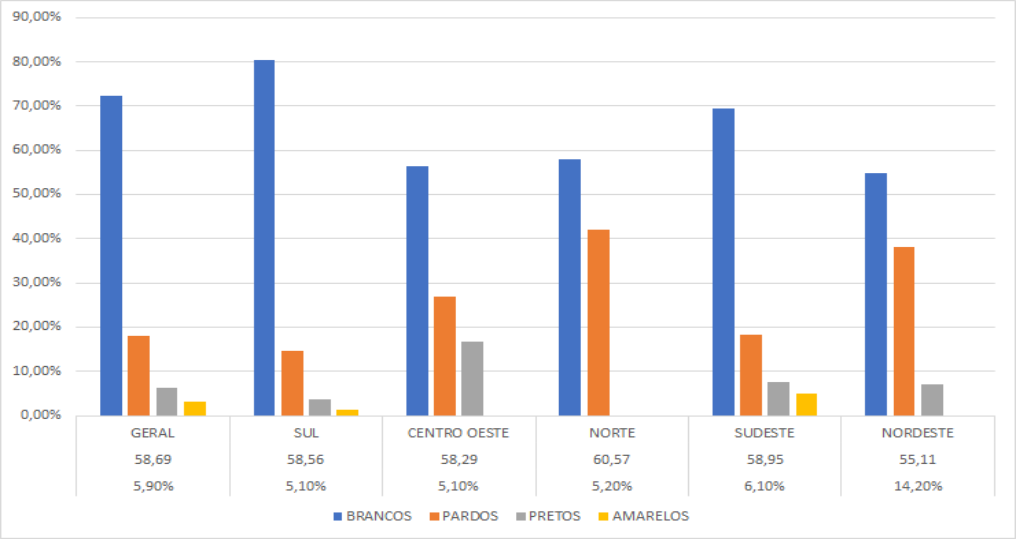


Fig. 9 - Graph that attempts to correlate the ethnic distribution of national regions with their average scores of the VVIQ questionnaire and the percentage of individuals with Aphantasia. Note that once again there is no correlation between these parameters and that the numbers do not follow the expected curve based on the data presented that there is a correlation between ethnic group and mental visualization capacity (as seen in Figs 6 and Fig. 7). Here, regions do not have scores consistent with the ethnic percentage they have.

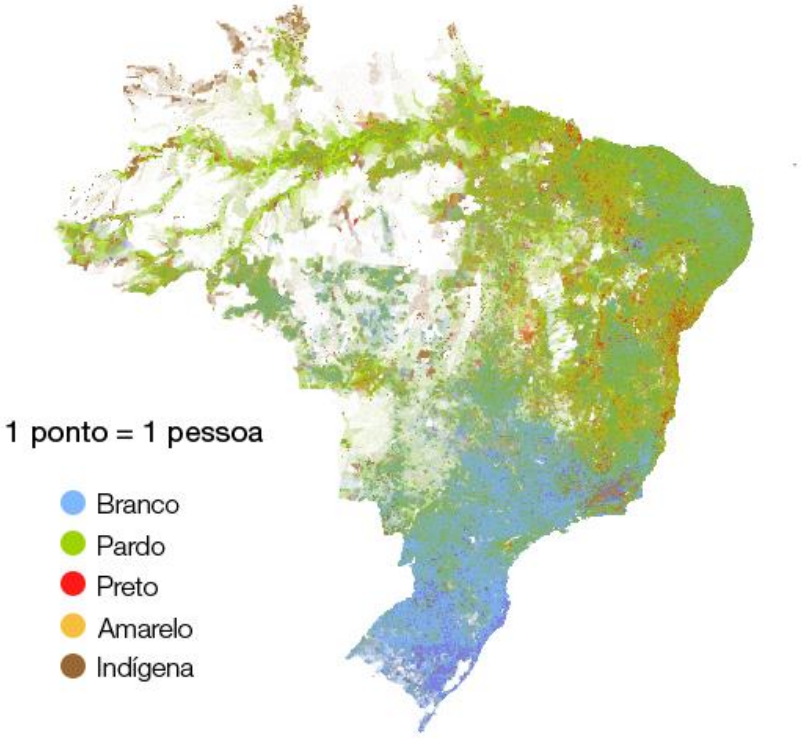


Translation:

General	whites
North	brown
South	black
Southeast	yellow
North East	
Midwest	

However, these inconsistent data do not cancel or invalidate the results that were discussed later, since there is this problem in relation to the amount and distribution already explained, besides that this distribution is not equivalent to the actual ethnic distribution of the Brazilian territory. According to the last census conducted by IBGE in 2010, Brazil is composed of 47.7% whites, 43.1% browns, 7.6% blacks, 1.1% yellows and 0.4% indigenous, and the distribution of ethnicities are different between regions. [9] (Fig. 10) In the Southeast and South regions, there is a prevalence of Whites to the detriment of other ethnic groups (55.2% in the Southeast and 78.5% in the South). [13] In the Midwest, Northeast and North regions, the predominance is brown (with 49.1%, 59.4% and 66.9%, respectively). These proportions are nothing similar to that of the research (with Region that presented only 2 ethnic groups, for example), which contributes to the correlation between the capacity of imagination and the populations of each of these Regions has been altered, and therefore does not correspond with reality. Therefore, it is necessary a sample space of each region larger and more reliable with real distribution of ethnicities so that some basis of analysis is established in a more consistent and coherent way.

Fig. 10 - Map of ethnic distribution in Brazil, according to the census made in 2010 by IBGE. [13]



Translation:
whites
brown
black
yellow
Indigenous

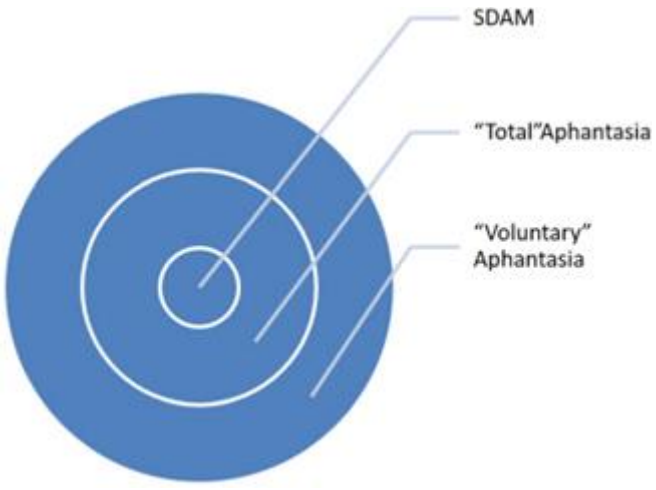
In addition to these questions aimed at identifying the participants and the VVIQ questionnaire, which scores the ability to imagine, other more specific and complementary questions were asked in the rest of the survey in a non-compulsory way and focused only on the Aphantasicos audience (people who scored below 32 points in the VVIQ questionnaire). There are 16 questions that cover some other interesting points about Aphantasia, which made it possible to understand a little more about this condition and to collect some other important data. It is worth remembering that, because they are not mandatory, not all participants with Aphantasia answered these questions and some of them answered incompletely. But, anyway, they are extra questions about the condition in order to delve a little deeper into this topic and understand it a little better. Therefore, it does not interfere with the results of the research. Based on these questions, the following data were raised: Of the 96 Aphantásicos, 76 (79.2%) reported having already noticed some difficulty or inability to form images with the mind, while 20 participants (20.8%) had already noticed. However, when asked about how and when these people were aware that they were not able to form images with mind, 23 of them (23.9%) reported having been through the VVIQ survey, and another 32 (33.3%) reported having been within the last few years (the amount ranged from 1 to 5 years), which confirms that most people who suffer from this condition end up being aware of it between adolescence and adolescents. and adulthood. [(4)] When analyzing the reports of how they came to the knowledge of the imaginative difference it had, it was interesting to note that the vast majority were through everyday activities, such as reading books, talking to friends, during some interactive activity that asked them to "visualize something", comparing with characters from movies and drawings in which they "imagined", seeing a video on Youtube that addressed this subject or in posts from other networks, when noticing worse performance in school subjects that require a higher degree of imagination (e.g., geometry), trying to do guided meditation or hypnosis, among other in numerations. Many others also report that they were unaware that they had no ability to see "since childhood". Others also report that they noticed this change after suffering from situations of stress, anxiety or some other type of psychological trauma, which is according to the evidence that it is possible to acquire Aphantasia. [(6)] Regarding the emotional impact, 64 participants (66.6%) reported having suffered some kind of emotional impact with this discovery and 27 participants (28.1%) reported not having suffered any kind of emotional impact with this discovery.

Questioned also about different forms that lack of imagination could manifest in these individuals. 38 participants (39.5%) stated that the lack of mental visualization was total, while 55 participants reported having image flashes (57.2%). 52 participants (54.1%) stated that imagination capacity was affected by the fact that the eyes were open or closed and 42 participants (43.7%) reported no difference. reported that they also had all kinds of imaginations affected (imagine sounds, textures, tastes and smells), in addition to the lack of visual imagination, and only 16 participants (16.6%) had only the imagination of vision affected. 39 participants (40.6%) had some of the imaginations of the other meanings affected, but not all. In the latter parameter, I obtained an even higher percentage of Aphantasicos with complete lack of multisensory

images, compared to Zeman's findings in his most recent research, which reports a percentage of 26.22%. (11)

In addition to these findings, another interesting finding was the fact that 66 of these participants (68.7%) declared that they dream normally and with visual images in dreams, many of them reported having very vivid dreams and even lucid dreams. This finding also corroborates with some previous studies that point to this same evidence, that even people with Aphantasia can see images in dreams. This may lead us to assume that perhaps the neural path way to the formation of images in dreams is different from the path to the production of mental images in wakefulness, although they may have common points. Despite being able to dream and have images in their dreams, some participants reported not being able to visually remember the images seen in dreams, even though they knew they saw it. These reservations regarding the dreams reported by some participants may be in connection with the findings of the next question. 60 participants (62.5%) reported being able to remember memorable events from their past (such as holidays or celebrations), but 34 participants (35.4%) reported not being able to remember these events from their past. Both data intersect with regard to memory. A study by researcher Nicholas W. Watkins had already raised this question about aphantasia's relationship with memory. (12) In this article, the researcher presents his own account as an Aphantásico, but also as a severely deficient Autobiographical Memory (SDAM). With his analysis and report, he raises a possible correlation between the two conditions. Aphantasia would be described in levels, layers in which visualization with "mind eye" is increasingly compromised. More superficially, it would be voluntary Aphantasia, when one voluntarily wishes to visualize some image. The next layer would be total Aphantasia, when voluntary and involuntary images (such as night dreams) are compromised. In the center, more deeply, one would find the SDAM, which could be understood as the deepest layer of Aphantasia, that is, it is necessary to have total Aphantasia to also have the SDAM, which compromises the memories.(Fig. 11)

Fig. 11 - Heuristic diagram used in the article "(A)phantasia and severely deficient autobiographical memory: Scientific and personal perspectives", exemplifying the model proposed by researcher Nicholas W. Watkins of aphantasia stratification. (11)



It is not yet known whether this proposal is fully confirmed, but the fact is that I could also observe that some people with Aphantasia reported having interference in their ability to autobiographical memories, which may point to a possible correlation between SDAM and Aphantasia.

Following the analysis of the other questions, we obtained that 60 participants (62.5%) believe that the lack of the mental eye causes some effect on their thought process and 26 participants (27%) believe that it does not cause any effect in the thought process. 86 participants (89.5%) believe that the lack of mental visualization did not affect their career choice, while 8 participants (8.3%) believe it affected them. At this point it is important to make certain comments and reservations about this data. Although most participants believe that they did not suffer influence from Aphantasia in their career choice, it should be recalled that most of them only realized that they had this condition already in the young or adult phase of life. [(4)] Because of this, the person did not necessarily have his or her choices changed upon discovering his condition, but they were, in a way, determined by him. Your tastes, your preferences and your thoughts have been shaped and developed coexisting with your pre-existing condition. So from her personal perspective she hasn't changed upon discovering her condition, he's always had that kind of taste or preference. However, his mind was "shaped" with this condition. Thus, considering that a person with Aphantasia has developed related to this condition, is there any area, career, or type of study in which these people are most attracted, precisely because of their lack of imagination? The results of this study lead us to believe that yes, there is a preference, or an area of knowledge in which these people are most attracted, which in this case are the careers identified as being in the exact area. Dalton, in the late 19th century, came to the conclusion with his study that "Men of Science" were more likely to be Aphantásicos. [(12)] The "Men of Science" dalton refers to his time were Mathematicians, Chemists, Physicists, professions that we now classify as exact, which aligns with the findings we obtained more than 200 years later. The researcher Nicholas W. Watkins, at the conclusion of his article, reveals that the presence of Aphantasia influenced him in the formation of his taste for the area in which he chose to work and also in parallel his non-affinity for other areas, that is, it was a previous determination that he suffered. Aphantasia shaped his tastes in order to bring him closer to what did not require him to view mental and to what reinforced his ease, in this case, abstract thinking. This determined directly on the path he chose to pursue a career. Perhaps he only realized the influence he suffered from Aphantasia after he became aware of his own condition, and did not realize before the bias that conditioned him. Aphantasia's influence on it had already begun at school level, reporting, for example, losing interest in organic chemistry by not being able to visualize the most complex molecules. [(12)] Given that no research so far has empirically verified the potential impact of the absence of visual images on broader cognition and how this extends to other internal experiences and mental processes,[(11)] further reinforces the importance of the study regarding Aphantasia and in understanding how it can influence the development of an individual, both academically and personally.

The next question is related to the same theme addressed earlier in relation to the influence of Aphantasia on memory. 43 participants (44.7%) reported no effects on their relationships (e.g., making it

more difficult to remember or imagine the faces of loved ones) while 48 participants (50%) stated that they felt effects on their relationships. This question converges in the same discussion about how much Aphantasia interferes with memory capacity. Considering what has already been discussed, it is noticed once again that there is a link between Aphantasia and memory capacity. In addition, we can observe that there is a certain spectrum of interference, even within the memory, because it is not all participants who have difficulty remembering events that also find it difficult to remember people, and vice versa. Thus, it can be assumed that there should be other factors that contribute to the construction or fixation of memories (such as, frequency with which the individual is in contact with what he intends to remember, or even important affective marks). Furthermore, based on the data found in this research and the conclusions of Adam Zeman's research "A cognitive profile of multi-sensory imagery, memory and dreaming in aphantasia", we can propose that there are other variations, besides those 3 proposed by Nicholas W. Watkins (Aphantasia Voluntaria, Aphantasia Total and SDAM), for Aphantasia. [11][12] A larger spectrum of Aphantasia subcategories could better explain the numerous variations and differences found in individuals who supposedly share the same condition, which shows us the possibility of interfering in each of them in different ways and degrees, forcing us to also update our understanding of this condition.

Following the analysis, 11 participants (11.4%) believe that the lack of the "mental eye" brings them some benefit and 77 participants (80.2%) believe that it does not bring them any benefit. 9 participants (9.3%) reported having a relative who also noticed the lack of the "mental eye", 12 (12.5%) declared that they did not have it and 70 participants (72.9%) stated that they do not know if they have any relatives who have also noticed the lack of the "mental eye", which does not rule out the possibility of any genetic or hereditary correlation for Aphantasia. Finally, the last question asked them to do a mental exercise counting the windows of their respective homes. 41 of these participants (42.7%) made this count in an alternative way to mental visualization of some species (for example, they already knew the amount of windows that existed in each room and then made the sum, but without having to actually visualize the rooms of the house).

7 GENERAL COMMENTS

It is important to highlight some limitations of the research that were taken into account at the time of tabulation, analysis and comparison of the collected data. Because it was a survey in which participants contacted her passively through social media, it depended on the personal interest of each one in answering and sending the questionnaire duly completed. In addition, the reach was, in a way, limited to my socioeconomic, cultural and regional circle by the social media algorithm, which brings certain limitations to dissemination, reinforcing the bubbles mentioned in which I belong. These factors may carry a certain bias and possible margins of errors for the results that were presented, such as the fact that the number of participants of each color/ethnicity is not equivalent and does not represent the actual national distribution, which generated results that were in disagreement with the evidence (as previously discussed).

There is the possibility that some people who chose to answer the questionnaire were more attracted to the subject by a certain identification, which could induce more responses from people with low mental viewing capacity. However, this possible bias dissolves when we present a large sample space of participants. We work with an N of 1627 participants. Thus, the possibility of errors and vieses of this type decreases in the face of the robust sample space analyzed.

He would like to highlight the various positive messages of the research participants, the compliments and thanks for the work, reinforcing the importance of the study on this topic and how it helped them to better understand their condition. This reiterates the relevance of this study and the positive impact it can generate on society.

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