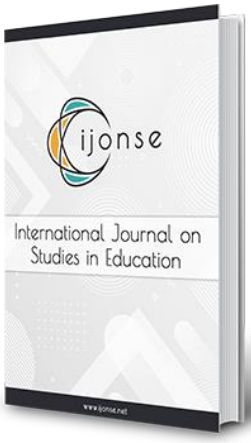

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Effect of Aphantasia on Academic Achievement and Learning Styles in Higher Education

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Abstract

This investigation targets to clarify Learning Styles (LSs) of aphantasic and non-aphantasic higher education students/graduates in accordance with Vermunt Learning Style Model and to LSs of the participants according to their demographic characteristics such as gender and age. Model of study is relational screening and research was carried out online with 260 volunteer participants. "Vermunt Learning Styles Inventory" was utilized to determine LSs of two separate groups with and without aphanatic. Although there are many studies on the LSs in literature, there are very limited study on the Vermunt Learning Style. Differences were found in the learning orientation and academic success of aphantasic people compared to non-aphantasic people. It was concluded that academic achievements of aphantasic participants were higher than the academic achievements of the non-aphantasic participants. When literature is examined, there is no research to examine level of imagination in terms of the LSs and academic success. Therefore, it is thought that the studies to be carried out by expanding scope with different sample groups will contribute to the aphantasic individuals, students and educators with this research. More studies can be done on this subject and experiments can be made for its use in the field of guidance.

Introduction

Every human being is born into a rapid circle of learning from the first day of existence. In general, learning is an active process in which we use objects, experiences, and conversations to mentally construct the world (Dewey, 1938; Piaget, 1964; Vygotsky & Cole, 1978). Looking at this definition, we can define the concept of learning as the ability to understand and organize our own learning process. Talents may not be realized to the same degree in every person. In this context, it is possible to say that individual variances are what cause learning to vary from person to person (Felder and Brent, 2005). At this point, it is crucial for individuals that persons know their own disparities and to discover their learning style accordingly. In order to see how college students engage in their learning activities, Vermunt (1995) produced an inventory of the LSs and correspondingly presented the Vermunt Learning Styles Model (VLSM). The inventory's goal is to ascertain how college students view their own learning and the processes involved in learning. Determining students' learning styles will allow educators to better understand them. However, what is important at this point is that the students' awareness of their individual differences is high.

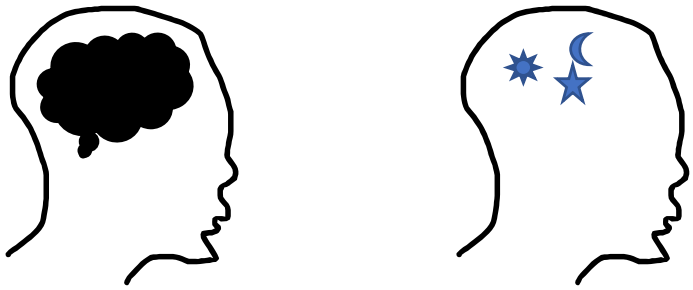

Figure 1. Representative Picture of Persons with and without Aphantasia

The word aphantasia, the root of the disease aphantasia, is phrase to define a person not seeing something when eyes are closed. It can be difficult for a student with opiate disorder to learn using visual elements, so teachers need to use different LSs. Because mental imagery is of great importancebecause it can accelerate learning and improve the performance of all kinds of skills (Schuster et al., 2011). In addition, those with aphanesis have a reduced ability to contribute to basic cognitive processes such as being able to visualize future events due to lack of visual imagery (Dawes et al., 2020).

Background

Aphantasia

To briefly define the term "aphantasia" is the lack of ability in a person to imagine mental images. In the first scientific study of this concept, Galton (1880), using the term "mental visualization", discovered that there are different degrees of ability to form vivid images in people's minds. Ongoing studies on the subject have also explained that the experience of imagery depends on the activity that allows us to produce images in the pre-parietal and posterior brain regions (De Vito & Bartolomeo, 2015; Ishai, 2010).

Visual imagery research was not in demand in years when behaviorism was embraced as psychological theory. Zeman et al. (2015) and Keogh and Pearson (2017) observed important change in the brain activation among people having aphanexia and control group, although two groups did not present difference in a spatial performance assignment in neurological investigation on aphanexia and spatial visualization. Investigators have also theorized that visual images in visual cortex are continued via feedback from frontal cortex, suggesting that persons having aphanexia can present different levels of activity in one or both of these parts of brain (Keogh and Pearson, 2017: 6).

Although researchers know that those with apantasia are unable to perform visual imagery, they estimate that they keep using of mentally visual images in diverse technique (Jacobs, Schwarzkopf & Silvanto, 2018). To investigate the inner workings of the mind-eye in more depth, Bainbridge et al. (2021) set out to investigate the differences among persons having aphanesis and people having usual imagery skills. It has been revealed that those with aphanesis have difficulty remembering the objects in the picture when drawing from memory.

The aphantasic group also used more symbols and text in their interpretation. As a result of the literature search,

aphane is seen as an individual difference and it is thought that it can affect the life of the individual in many ways. Learning is a process that continues throughout our lives, and visual images are one of the personal toolkits used in learning activity. Thus, the LSs and aphanexia are a topic that needs to be investigated.

Learning Styles (LSs)

Several definitions exist for the LSs as a result of literature screening and often cause misunderstanding for dissimilarities and similarities between learning methods, working approaches, orientations, patterns, process and strategies of the learning (Coffield, Moseley, Hall, and Ecclestone, 2004; McManus et al. 2004). The LSs have been measured by educators and psychologists using a number of assessment techniques. Scientists who study the LSs have suggested several descriptions of the LSs. For example, McCarthy (1987) defines the LSs as "the preferences of the individual in the perception and processing of information", while Grasha (1996) describes the LSs as follows: "It is the ability to combine skills and learning experiences in the process of acquiring knowledge." Dunn and Dunn (1993) assert that each person has a distinctive the LSs that is similar to a fingerprint.

Inventory of Learning Styles (ILSs)

Vermunt (1995) defined Inventory of Learning Styles (ILSs) as "processing strategies involving awareness of the goals and objectives of learning activities applied to determine what is learned, regulatory strategies for monitoring learning, mental learning models". ILSs were developed by Vermunt as diagnostic tool to investigate learning processes of students in higher education (Busato, Prins, Elshout and Hamaker, 1998, 1999). The ILSs have been employed in several academic investigations at universities. Educational psychology and constructivist philosophy are the foundations of the inventory. (Boyle, Duffy and Dunleavy, 200). The inventory's goal is to find out how higher education students view their own learning and the learning processes that they engage in (Vermunt, 2005).

Purpose

It is understood from the literature that different scientists at different times of the Visual Imagination (VI) have been working in areas such as the problem-solving skills related to visual imagination, the goal of becoming an academician, psychology and neuroscience. In the light of these and similar studies, the effect of aphantasia on learning styles and academic success has been found worthy of investigation. According to the results of the literature review, no research was found on the learning styles and academic achievements of people with opitasis. In addition, literature shows that the Vermunt Inventory of Learning Styles (VILSs) have been utilized by investigators in many countries (Vermunt and Vermetten, 2004).

The goal of this investigation is to study association among the LSs and academic achievements of participants who are and are not aphantasic. According to this goal, the study's sub-objectives are as follows;

1. Is there important variance between LSs of people who are and are not aphantasic?
2. Is there a significant difference between the academic achievements of people who are and are not

aphantasic?

3. Does perceived success depend on the viability variable of the visual image?
4. Is there significant connection among Visual Imagination Vitality (VIV) and LSs? preferred formats.

Method

In this study, the screening model was used. It is a methodology defining, illustrating and explaining past and current states, groups, objects, and characteristics. In screening model, situations, person, and objects, which are the subject of investigation, are all attempted to be characterized in their unique conditions (Büyüköztürk et al., 2014). Two different scales were applied to participants to investigate whether aphantasic had an impact on the LSs and academic success. First, "Vividity of Visual Imagination Scale (VVIQ)" was applied to the participants in order to determine whether they were aphantasic or not. The fact that the participants scored 16 on the scale shows that they are completely aphanatic (Zeman, 2015). It was studied whether the LSs of aphantasic and non-aphantasic higher education students showed a statistically important change according to the VILSs.

Participant

The research was carried out with 260 higher education students/graduates who participated in the survey conducted on social media. 70% of the participants who voluntarily participated in the study were female (n=182) and 30% (n=78) were male. Necessary ethical permissions have been obtained for the collection of data. The scales in the study were first applied to all faculties of a university, but since the students switched to online education due to the COVID-19 outbreak and there were problems in delivering the scales to the students, the scales were applied to a more limited group of people. Scales were shared on the "Graduate Solidarity Platform" on Facebook and the scales were applied to the participants online. In order for the scales to be applied smoothly, participants were made aware of the study's objectives and characteristics of scale. The application of the scale was completed in about three months. Participants voluntarily participated in the study.

Data Collection

Participants in investigation were questioned to fill out the VVIQ and "Vermunt's Learning Styles Scale", which are short self-notification tools.

Scale of Vividity of Visual Imagination (VVIQ)

The Scale of the Vitality of the Visual Image, developed by Marx (1973), is a scale in which the participant is invited to think about the image formed in the mind when thinking about certain scenes and situations. This scale consists of 4 main items and a total of 16 items. The vitality of the image is rated on a 5-point scale. 5 points means there is no image at all, while 1 point means there is no image at all, while 5 points means perfect as the real vision. A participant who gave 1 point to all questions on the scale scored 16 points and was categorized as apathetic. It is frequently used to assess individual variations in the vividness of visual imagery.

Vermunt's Inventory of Learning Styles (VILSs)

Another data collection tool utilized in the research is the learning styles inventory produced by Vermunt (1998). The VILSs aim to clarify how students perceive their own learning. In VILSs, questions are in the five-way likert style and consist of 100 items. The Learning Styles Inventory consists of two sections and subdivisions.

Data Evaluation

The statistical package software SPSS 20.0 was used to examine the data. Normality testing was first done to clarify whether data displayed a common distribution. The distinct samples t-test to clarify effect of visual image's viability variable on learning styles after the data are seen to show standard distribution, independent samples t-test to clarify effect of VI viability variable on the undergraduate achievement grade, Chi-Square Test to reveal whether perceived success is dependent on the viability variable of visual imagery, viability of visual imagery, undergraduate achievement grade and in order to ascertain the connections among different LSs, Pearson correlation analysis was used..

Table 1. Cronbach α Coefficients of Scale and Factors belonging to the LSs Scale

Vermunt Learning Styles Scale		
	α Value	
	Factors	**The entire scale**
Process strategies	.891	.921
Editing strategies	.849	
Mental model in learning	.794	
Learning orientations	.805	
VVIQ		
		α Value
Vividness of VI		.978

Reliability coefficients of scale and sub-dimensions utilized in investigation were determined and given in Table 1. It was concluded that α coefficients of scale validity were above .70 and therefore scales were reliable (Büyüköztürk, 2006).

Table 2. VILSs and Normality Tests of Scale of Viability of Visual Imagery

	Average	**Std.**	**Mode**	**Median**	**Z Skewness**	**ZFlattening**
Process Strategies	3.33	.71	3.67	3.43	-1.78	-.89
Editing Strategies	3.37	.64	4.00	3.44	-1.47	-1.34
The Mental Model in Learning	3.72	.50	3.52	3.76	-.90	-58
Learning Orientations	3.61	.57	3.85	3.80	-1.89	1.76
License Grade	3.01	.49	3.16	3.05	.001	1.28
Visual Imagery Vitality	47.70	21	16	54.5	-1.56	-1.81

The mean, mode, median, skewness and flatness rates of variants based on investigation were determined and given in Table 2. If the mean, mode, and median rates are the same in series frequency distribution, it is possible to state that the data is dispersed symmetrically around the primary trend measurements. By examining the Z points of the skewness and flatness values in situations when these values are not equal to one another, it is possible to determine whether the series is normally distributed or not. The data reflect normal distribution since the Z scores of the skewness and flatness factors remain within the range of (±1.96) (Field, 2009).

Results

The research's conclusions in accordance with the main goals and secondary goals are presented in this part. The distribution of the apathetic and non-apathetic individuals participating in the study in the categories of gender, age, educational status and achievement perception is presented in Table 3.

Table 3. Demographic Info of Participants

		Groups				**Sum**	
		Aphantasic		**Not aphantasic**			
		N	%	N	%	N	%
Gender	Female	50	19%	132	51%	182	70%
	Male	14	5%	62	24%	78	30%
	Sum	64	25%	196	75%	260	100%
Age	18-22	7	3%	23	9%	30	12%
	23-27	26	10%	62	24%	88	34%
	28-32	12	5%	41	16%	53	20%
	33-37	7	3%	30	12%	37	14%
	38-42	8	3%	18	7%	26	10%
	42+	4	2%	12	5%	16	6%
	Sum	64	25%	186	72%	250	96%
Education status	Undergraduate	33	13%	161	62%	194	75%
	Graduate	31	12%	35	13%	66	25%
	Sum	64	25%	196	75%	260	100%
Perception of success	Yes	39	15%	100	38%	139	53%
	No	12	5%	53	20%	65	25%
	Partly	13	5%	43	17%	56	22%
	Sum	64	25%	196	75%	260	100%

Out of a total of 260 survey participants, women (n=182) were more likely than men (n=78). The age range is maximum 23-27 (n=88). The educational status of the participants is undergraduate (n=194) and graduate (n=66) person. According to the Scale of the Viability of Visual Imagination, (n=64) of these people are not aphantasic (n=196). According to Table 4, 13% of the people who are aphantasic have received undergraduate education and 12% have received postgraduate education, while 75% of non-aphantasia people have received undergraduate

education and 25% have received postgraduate education. 15% of people with aphane consider themselves successful, while 38% of non-abantasic people consider themselves academically successful.

According to Table 4, the process strategies of the aphantasic people who participated in the study were higher than the process strategies of establishing and regulating, memorizing and repeating than those who were not aphantasia. Critical processing, analysis and concrete processing are lower.

Table 4. Average and Standard Deviation Rates of Responses of Aphantasic and Non-apathetic Individuals to the Process Strategies Subcategory of their LSs

	Aphantasic		**Not aphantasic**	
	Avg.	**Std.**	**Avg.**	**Std.**
Process Strategies	3.27	.74	3.36	.71
Establish-edit relationships	3.32	1.09	3.11	1.05
Critical processing	2.91	1.16	3.24	.85
Memorization and repetition	3.51	1.14	3.41	.85
Analyze	2.79	.91	3.02	.90
Concrete processing	3.93	.80	4.01	.85

The average of the Regulation Strategies for aphantasic people according to the learning processes and content of internal and external regulation and lack of regulation is lower than for non-aphantasic people (see Table 5).

Table 5. Average and Standard Deviation Values of Responses of Individuals with and without Aphantasic to Subcategory of Regulation Strategies of their LSs

	Aphantasic		**Not aphantasic**	
	Avg.	**Std.**	**Avg.**	**Std.**
Editing strategies	3.29	.59	3.41	.66
Self-regulation of learning processes and outcomes	3.36	1.02	3.65	.90
Self-regulation of learning content	3.36	.93	3.47	.96
Extrinsic regulation in learning processes	3.07	.78	3.08	.92
External regulation of learning outcomes	3.45	.75	3.60	.68
Lack of regulation	3.26	.72	3.31	.87

According to Table 6, mental models in learning averaged higher information structuring, acceptance and use for non-aphanatic people, while non-apathetic people had higher stimulus training and cooperation. As it is understood from the Table 7, the learning orientation of the participants was higher than the average of those who were not aphantasic in the other four sub-dimensions, except for those whose learning orientation was unstable. Those with unstable learning orientations had a higher average of non-aphantazic ones. As seen from the Table 8, according to outcomes obtained from the t-test for independent samples done to clarify of VI vitality variable on learning styles, the scores of the participants regarding the learning orientations they received from the scale differed statistically significantly according to the level of vitality of the VI ($p = .001$). Scores for other sub-dimensions on the learning styles scale are not affected by the level of vividness of the visual image.

Table 6. The Mean and Standard Deviation Rates of Responses of LSs of Aphantasic and Non-aphanatic Individuals to Subcategory of Mental Model in Learning

	Aphantasic		Not aphantasic	
	Avg.	**Std. Deviation**	**Avg.**	**Std.**
Mental model in learning	3.64	.44	3.75	.52
Structuring information	4.02	.79	3.68	.80
Acceptance of information	3.88	.72	3.68	.62
Use of information	4.33	.61	4.16	.64
Stimulating training	3.67	.89	4.01	.91
Collaboration	2.56	1.00	3.30	.80

Table 7. Average and Standard Deviation Rates of Responses of Individuals with and without Apathetic to Subcategory of Learning Orientations of their LSs

	Aphantasic		Not aphantasic	
	Avg.	**Std.**	**Avg.**	**Std.**
Learning orientations	3.74	.36	3.58	.63
Individual attention	4.43	.48	4.39	.61
Approved purpose	3.46	1.01	2.89	.90
Self-tested oriented	3.75	.83	3.62	.95
Profession-oriented	4.12	.60	3.85	.88
Undecided	2.89	.85	3.39	.91

Table 8. t-test Results for Independent Samples conducted to determine Effect of Viability Variable of VI on Learning Styles

	Groups	**N**	$\bar{X}$	**Ss**	$Se_{\bar{X}}$	**t Test**		
						t	**Sd**	**p**
Process Strategies	Aphantasic	64	3.27	.74	.09	-.915	258	.361
	Not Aphantasic	196	3.36	.71	.05			
Editing Strategies	Aphantasic	64	3.29	.59	.07	-1.391	119.052	.167
	Not Aphantasic	196	3.41	.66	.05			
The Mental Model in Learning	Aphantasic	64	3.64	.44	.05	-1.640	126.685	.103
	Not Aphantasic	196	3.75	.52	.04			
Learning Orientations	Aphantasic	64	3.74	.36	.05	2.564	187.263	.011*
	Not Aphantasic	196	3.58	.63	.04			

* Significant at .05 level

As given in Table 9, a statistically important change was observed in average of undergraduate achievement grades of the participants according to the level of vividness of the VI (p = .016). It is seen that the undergraduate average of aphantasic people (X = 3.14) is statistically higher than those who do not (X = 2.97). According to the results obtained from Chi-square test done to determine whether success levels perceived by the participants were dependent on their visual imagery vitality, no relationship between these two categorical variables could be

determined (p = .321) (see Table 10).

Table 9. t-test Results for Independent Samples to determine Effect of Vitality Variable of VI on Undergraduate Achievement Grade

	Groups	N	$\bar{X}$	Ss	$Sh_{\bar{X}}$	t Test		
						t	Sd	p
Undergraduate passing grade	Aphantasic	64	3.14	0.45	0.06	2.41	255	.016*
	Not aphantasic	196	2.97	0.50	0.04			

* Significant at .05 level

Table 10. Chi-square Test Results to determine whether Perceived Achievement Depends on Viability of VI Variable

Groups	Perceived achievement level			Sum	X^2	Sd	P
	Yes	No	Partly				
Aphantasic	39	12	13	64	2.273	2	.321
Not aphantasic	100	53	43	196			
Sum	139	65	56	260			

As given in Table 11, as an outcome of Pearson correlation analysis applied to clarify relationships between vitality of visual imagery, undergraduate achievement grade and learning styles, it was observed that the positive low correlation exists among vitality score of visual imagery and undergraduate achievement grade (r = .147) and the mental model factor score in learning (r = .127) at the level of .05 significance. However, relationships have also been identified between the LSs. Positive direction moderate correlation exists among process strategies and regulation strategies (r = .696) at the level of .01 significance, a positive direction low correlation between the mental model in learning (r = .204) at the level of .01 significance and a positive direction low correlation between learning orientations (r = .142) at the level of .05 significance.

Table 11. Pearson Correlation Analysis to determine the Relationships between Vividity of Visual Imagery, Undergraduate Achievement Grades and Learning Styles

	X	Ss.	1	2	3	4	5	6
Vividity of Visual Imagery	47.71	21.14	1	.147*	-.019	.073	.127*	.106
License Grade	3.01	0.49		1	.043	.036	.040	.061
Process Strategies	3.34	0.71			1	.696**	.204**	.142*
Editing Strategies	3.38	0.64				1	.397**	.560**
Mental Model in Learning	3.72	0.51					1	.363**
Learning Orientations	3.62	0.58						1

* Significant at .05 level

** Significant at .01 level

There was a positive direction and low correlation among regulation strategies and mental model in learning (r = .397) at the significance level of .01 and the positive moderate correlation between the learning orientations (r = .560) at the level of .01. A low positive correlation was found between the mental model in learning and learning orientations (r = 363) at the .01 significance level.

Discussion and Conclusion

This study was conducted to reveal whether aphantasia has an effect on learning styles and academic achievement. The Vitality of Visual Images Scale was applied to individuals who defined themselves as aphantasic and did not identify themselves on the internet, and those who scored 16 on the scale were categorized as aphantasic. These two separate groups were given Vermunt's Inventory of Learning Styles and were additionally asked questions about their academic achievements.The scores of the participants regarding the learning orientations they received from the scale differed statistically significantly according to the level of vividness of the visual image. Scores for other sub-dimensions on the learning styles scale are not affected by the level of vividness of the visual image. The subcategory Learning Orientations has 5 sub-dimensions. These are listed as individual interest, approved purpose, self-test oriented, profession-oriented and undecided. When the data of the responses of individuals with and without aphane to the subcategory of learning orientations are examined, there is more difference in 2 sub-dimensions than in other dimensions. The average of responses to the sub-dimension of approved purpose is higher for people with aphantasic than for non-aphantasic people. According to this result, it can be said that the learning orientations of the people who are aphantasic for the study group are more for the approved purpose than for the non-aphantasic people. Also, according to the outcomes of investigation, it can be concluded that people who are aphantasic are more professionally oriented than non-aphantasic people. Despite these results, Liu & Bartolomeo (2023) found in their study that people with aphantasic process information more slowly. It is thought that these differences in the results may be due to the smaller sample in the current study. However, the results are consistent with the conclusion of Keogh et al. (2021), who studied memory, that there was no significant difference between aphantasic and non-aphantasic individuals.

When the effect of the vividness variable of visual imagination on the undergraduate success grade is examined, it is seen that the undergraduate average of aphantasic people is statistically higher than that of non-aphantasic people. Bates (2021) stated that aphantasic individuals can lead to alternative strategies that improve rather than inhibit learning. According to the results of the research, this result is in parallel with the result reached by Bates. However, Sadoski does not parallel Goetz & Kangiser (1988) to his work in which he states that creating visual images while reading a text helps with comprehension and remembering, and that reading comprehension and school achievement are strongly correlated. According to the results of the study, people who cannot make visual imagery have more academic achievement, even if it is a low rate, than people who can make visual imagery. Kay et al. (2024) stated that visual images are not very important in mental performance between aphantasic and non-aphantasic students, similar to this result. In short, according to these studies, it can be concluded that high visual imagination does not have a positive effect on academic achievement. No relationship has been identified between perceived success and the variable of the vitality of the visual image. According to the result obtained, the vitality of the visual imagination has no effect on whether individuals see themselves as successful or not. When the

relationships between the vitality of visual imagery, undergraduate achievement grade and learning styles were examined, a positive low relationship was observed between the vitality score of visual imagery and the undergraduate achievement grade and the mental model factor score in learning . In addition, relationships have been identified between learning styles. A positive moderate relationship was found between process strategies and regulation strategies. There was a positive direction and low correlation among mental model in learning and a positive direction low correlation between learning orientations. There was a positive direction and low correlation among regulation strategies and mental model in learning and the positive moderate correlation between the learning orientations. A low positive correlation was found between the mental model in learning and learning orientations. Westby (2024) stated that children with afantasia will have difficulty in learning as a result of what is learned in this direction consists of visual images.

According to the findings obtained from the study, there are significant differences in the personality characteristics of the participants with and without aphantasia in some imagery sub-dimensions according to demographic variables. When the literature is examined, there is no research to examine the level of imagination in terms of learning styles and academic success. Therefore, it is thought that the studies to be carried out by expanding the scope with different sample groups will contribute to aphantasic individuals, students and educators with this research. In the light of this study and similar studies, emphasizing the importance of imagination and creating awareness of the potential to contribute to academic development is of great importance in the field of educational sciences.

Recommendations

The following suggestions are provided in accordance with the findings of the study and their interpretations.

Recommendations for Research Results

- The impact of aphantasic on learning styles should be considered more comprehensively.
- Role of different variables in influence of visual imagery skills on academic achievement can be examined.
- Studies to be carried out by expanding the scope with different sample groups can contribute to aphantasic individuals, students and educators with this research.
- Experiments can be made for its use in the field of guidance.
- The sample and study groups can be expanded and repeated.

Recommendations for Educational Practitioners

- Teachers should be aware of the personal characteristics of their students in their classrooms and shape them by considering these features in the entire teaching process.
- Teachers should read the studies on this subject and arrange their lessons accordingly if their students cannot make visual imagery.

- Teachers should know a student's learning style and keep track of how students call their learning.

Recommendations for Researchers

Aphantasia is a newly discovered concept and studies on this topic are limited in the literature. In particular, there are no studies on aphane and learning styles. Therefore, there is a need for researchers to be interested in this issue and to conduct in-depth research. This study was conducted online on higher education students and graduates. It can also be carried out in different age and educational groups and in other areas related to education.

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