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Development of the Indonesian Version of the Object-Spatial Imagery and Verbal Questionnaire (IDN-OSIVQ)

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Abstract

Developing the Indonesian Version of the Object-Spatial Imagery and Verbal Questionnaire (IDN-OSIVQ) aims to create a culturally adapted and validated instrument for assessing object-spatial imagery abilities in the Indonesian population. The research utilized a developmental method to test the instrument's reliability and validity through rigorous adaptation procedures, including translation, back-translation, expert review, and pilot testing. Data from 153 students were analyzed to establish the internal consistency, construct validity, and factor structure of the IDN-OSIVQ. Results showed that the IDN-OSIVQ scales had satisfactory internal reliability, with principal component analysis confirming distinct and coherent factors. Object imagery had the highest average score (3.6662), while spatial imagery had the lowest (3.1765). Criterion validity was established as participants' ratings correlated favorably with corresponding tasks. Gender differences were observed: men scored higher on spatial imagery and women on object imagery, yet these differences did not overshadow the strong associations between cognitive style ratings and objective measures. The cultural adaptation process ensured the questionnaire's relevance and comprehensibility, enhancing its applicability. The findings support the IDN-OSIVQ as a reliable and valid tool, suggesting future research should involve more diverse age groups.

INTRODUCTION

Cognitive development related to object-spatial imagery is crucial for students' academic achievements and cognitive abilities, especially in STEM subjects (Atit & Rocha, 2021). Object-spatial imagery, the ability to visualize objects in space, strongly correlates with different types of thinking and problem-solving skills (Haciomeroglu & LaVenia, 2017). Individuals with strong spatial imagery perform better in complex tasks (Kibar & Akkoyunlu, 2016), and mental imagery can enhance motor skills (Jofré et al., 2019). This ability also aids in academic performance and career guidance, with variations in imagery preferences influencing academic curiosity and competence. Visual-spatial representations are critical in mathematics education, enhancing problem-solving skills.

However, cognitive development issues, such as visual processing disorders and spatial difficulties, can hinder learning (Sigurdardottir et al., 2017). Research conducted by the Centers for Disease Control and Prevention (2022) indicates that approximately 2% of adults experience visual agnosia, 5% of children experience visual processing disorders, 2% of children experience dyspraxia, 10% of children experience spatial difficulties, and 1% of children experience delays in cognitive development. Cognitive impairments affect object recognition, visual information processing, movement planning, spatial understanding, and orientation, leading to delays in cognitive development and difficulties in learning and communication (Otumfuor & Carr, 2017; Marinelli et al., 2022).

It is essential to explain the various measurement tools used to globally measure object-spatial imagery, such as the Mental Rotation Test (MRT), Paper Folding Test (PFT), and Visual Patterns Test (VPT). These tools measure spatial imagery ability, such as mental rotation, paper folding visualization, and visual pattern recognition. The Object-Spatial Imagery and Verbal Questionnaire (OSIVQ) was reviewed compared to other measurement tools because the OSIVQ assesses spatial imagery and includes verbal and object imagery dimensions, offering a more comprehensive assessment. As a self-report tool, the OSIVQ allows the assessment of subjective aspects not covered by other objective measurement tools. Its good validation in various cultural contexts makes the OSIVQ relevant for adaptation and use in the Indonesian context.

The Object-Spatial Imagery and Verbal Questionnaire (OSIVQ), developed by Blazhenkova & Kozhevnikov (2009), is widely used to evaluate object-spatial imaging abilities. It measures verbal cognitive techniques, spatial imaging, and object imagery variations. However, self-report tools like OSIVQ can have biases and errors affecting reliability. Spatial ability assessments involving tasks like visualizing and mentally rotating scenes provide additional insights but may not capture the full complexity of object-spatial imagery skills (Rochester, 2020). Instruments examining spatial reasoning in geometric problem-solving (Buckley et al., 2018) and cognitive flexibility in elementary math problem-solving (Rahayuningsih et al., 2020) offer further understanding of student strategies but may miss subtle cognitive nuances. Therefore, while tools like OSIVQ and spatial ability tests are valuable, researchers should use a combination of instruments to understand students' object-spatial imagery skills better.

Furthermore, a study conducted by Bled and Bouvet (2021) validated the French version of the Object Spatial Imagery and Verbal Questionnaire (OSIVQ), which evaluates cognitive style dimensions such as object imagery, spatial imagery, and verbal aspects. This reference is relevant as it directly addresses the adaptation and validation of an instrument closely related to the IDN-OSIVQ. In addition, a study by Aydin (2020) on gender differences in visual imagery, precisely object and spatial imagery, provides insight into how imagery skills are assessed through questionnaires. Understanding such nuances in assessing imagery skills can be valuable when developing and validating the IDN-OSIVQ for the Indonesian context. Based on the explanation of previous research, which focused on the adaptation and validation of instruments such as the OSIVQ, which assesses cognitive style dimensions related to object and spatial imagery. This research offers a foundation for the development and validation of the IDN-OSIVQ, emphasizing the importance of cultural adaptation and validation processes to ensure the reliability and validity of the instrument in the Indonesian context.

The conceptual framework of two distinct visual and verbal processing systems is the primary reliance of previous research on the visual-verbal cognitive style. However, these studies lack grounding in cognitive theories that elucidate the brain's information-processing mechanisms, and they often fail to apply rigorous theoretical principles to measure this dimension accurately. Also, it is essential to acknowledge the limitations and considerations associated with these instruments. As a result, these include learning preferences, problem-solving strategies, the degree to which one relies on visual or verbal cues for accuracy and recall, and the timing with which one responds on aptitude tests that measure verbal or visual skills. This diversity has led to the development of multiple assessment tools, ranging from individual response measures to cognitive tasks that underlie more intricate behaviours.

The cultural adaptation of the IDN-OSIVQ involved several important steps to ensure that the instrument is relevant and valid in the Indonesian cultural context. First, a linguistic translation was conducted to ensure that Indonesian respondents could clearly understand all terms and statements in the questionnaire without changing the original meaning of the instrument. Secondly, cultural adjustments were made by considering the differences in how Indonesians view and perceive concepts such as object image, spatial image and verbal image. For example, some of the terms or examples used in the original version may be irrelevant or unfamiliar to Indonesian respondents, so they need to be replaced with terms or examples that are more commonly recognized in Indonesian culture. In addition, an initial pilot test was conducted to evaluate whether the adaptations were appropriate and identify potential problems in understanding or interpreting the questionnaire items. The results of this pilot test were then used to make further adjustments. By making careful cultural adaptations, the Indonesian version of the IDN-OSIVQ is expected to measure cognitive style accurately and relevantly in the Indonesian cultural context, which differs from the original version and may be more appropriate in the Western context.

This study emphasizes novelty by developing and validating the Indonesian version of the Object-Spatial Imagery and Verbal Questionnaire (IDN-OSIVQ), which has not previously existed. The profound cultural adaptation ensures that the instrument is relevant in the Indonesian context, unlike previous studies by Bled and Bouvet (2021) and Aydin (2020), which only focused on validation within their own cultural context. In addition, this study complements previous studies by providing empirical data on cognitive styles in Indonesian culture, enriching the cross-cultural cognitive psychology literature with specific and relevant new findings. The development of this instrument is necessary because many English-adapted instruments show ambiguity in meaning, which causes bias in research.

The IDN-OSIVQ was developed and validated as a new instrument to assess three dimensions: a new verbal scale and the established object and spatial scales. This self-report measure is essential because it assesses subjective aspects, such as the color and brightness of mental images and verbal cognition (e.g., sentence structure). It provides insights that cannot be achieved through existing objective assessments, which take up to an hour per subject to evaluate cognitive style, making self-report much more efficient. In addition, there is a lack of verbal scales comparable to existing visual-objective and visual-spatial scales. Previous instruments, such as Richardson's VVQ (1977), only test fluency and speech expression, so a broader evaluation is needed. The primary purpose of this study was to construct and assess the factor structure, internal reliability, and descriptive properties of the IDN-OSIVQ and determine its validity by investigating its relationship with relevant variables.

METHOD

Population And Sample

In this study, the population refers to all students aged 13-18 in Indonesia who can be subjects for research to assess their cognitive styles. This population includes students from diverse educational, geographical, and socio-economic backgrounds. Given the broad scope of this population, the study focuses on students within the teenage age range, which is a critical period for cognitive development.

The research sample consists of 153 students aged 13-18. The selection of this sample is based on the research by Fadillah (2016), which also used a similar sample in a study on cognitive styles using tests and questionnaires. The sampling method was aimed at obtaining an accurate representation of the larger population. Therefore, this sample is considered sufficiently representative of the variation in cognitive styles among teenage students in Indonesia.

Research Procedure

The research procedure includes several important stages. First, a translation process was conducted to ensure that the IDN-OSIVQ questionnaire was accurately translated into Indonesian. This process involved professional translators and a review by language experts to ensure the fidelity of the translation to the original version. Next, an expert judgment was carried out by experts in cognitive psychology and education to assess the suitability of the items in the questionnaire with the cultural and linguistic context of Indonesia. A pilot instrument test was conducted on a small sample to identify and correct any unclear or inappropriate items before using it in the main study.

Validity Criteria Variables

The variables used as criteria in the criterion validity test were selected based on their relevance to the measurement of cognitive styles assessed by the IDN-OSIVQ. These variables included the participants' academic performance, results from other cognitive tests, and self-reports on using cognitive strategies in daily tasks. These variables were selected through a comprehensive literature review and consultation with experts in educational psychology. The aim was to ensure that the chosen variables accurately reflect the cognitive style dimensions measured by the IDN-OSIVQ questionnaire.

Questionnaire Administration

The IDN-OSIVQ questionnaire was administered to participants individually. Each participant was given clear instructions on responding to each item in the questionnaire. They were asked to read each statement carefully and rate it on a scale from 1 to 5 based on their level of agreement. There was no strict time limit for completing the questionnaire, allowing participants to provide more reflective and accurate responses. During the data collection process, special considerations included ensuring a calm and comfortable environment for the participants and providing additional explanations if there were any questions or confusion about the instructions.

Measurement Model

The measurement model used in the confirmatory factor analysis (CFA) was determined based on the theoretical structure of the IDN-OSIVQ, which consists of three dimensions: verbalizer (V), visualizer spatial (VS), and visualizer object (VO). CFA was used to test the fit of this model with the collected data. This process tested whether the questionnaire items statistically supported the hypothesized three-dimensional structure. The measurement model was determined through an initial analysis using Exploratory Factor Analysis (EFA) to identify patterns of relationships among the items, followed by CFA to confirm and validate the resulting factor structure.

Data Analysis

Normality Test

In this investigation, Kolmogorov-Smirnov was utilized to test for normalcy. The data is considered normal if the p-value is higher than 0.05. If, on the other hand, the p-value is less than 0.05, the data is considered to be abnormal.

Criterion Validity of the IDN-OSIVQ

Using a Discriminant Validity test, which requires a cross-loading of more than 0.6 for each variable, the researcher examined the reliability and validity of the IDN-OSIVQ. When one measurement item's construct correlation is higher than the other construct measures, the latent construct can better predict the value of one set of variables.

Confirmatory Factor Analysis

A correlation test was conducted to determine the correlation of cognitive styles on the three dimensions.

Test-retest Reliability

The subsample of participants who filled out the measures for research questions 1 and 2 (N=45) was given the IDN-OSIVQ again, with a 2-week interval between the two administrations, to evaluate test-retest reliability. Composite Reliability, Cronbach's Alpha, and Average Variance Extracted (AVE) are the tools used in the reliability test. If a construct has a Cronbach Alpha value greater than 0.6, rho_A and Composite Reliability values greater than 0.7, and an Average Variance Extracted (AVE) value greater than 0.5, it can be considered trustworthy.

RESULTS

Analysis Demographic

Demographic tables describe the distribution of the research sample based on specific demographic characteristics, such as gender and age. This table helps provide an overview of the profile of the research participants and ensures that the sample used is representative of the population under study. The following is the demographic table in this study:

Table 1
Characteristics Based on Gender

No	Gender	Amount	Percentage
1	Male	64	41,8 %
2	Female	89	58,2 %
	Total	153	100%

Source: Primary Data Processed (2023)

Out of the 153 students in the sample, 64 (41.8%) are male. On the other hand, there are 89 female students, making up 58.2% of the sample. This indicates that the sample has a higher proportion of female students than male students. The gender distribution is essential for understanding the demographic composition of the sample, which can influence the results and interpretations of the cognitive style assessments carried out using the IDN-OSIVQ questionnaire.

Table 2
Characteristics by Age

No	Age	Amount	Percentage
1	13 years	10	6,5 %
2	14 years	8	5,2 %
3	15 years	22	14,4 %
4	16 years	14	9,2 %
5	17 years	49	32 %
6	18 years	50	32,7 %
	Total	153	100%

Source: Primary Data Processed (2023)

The age distribution of the sample shows a varied representation across the teenage years. Among the 153 students, 8 students (5.2%) are 13 years old; 10 students (6.5%) are 14 years old; and 14 students (9.2%) are 15 years old. There are 22 students (14.4%) aged 16 years, while the most represented ages are 17 and 18. Specifically, 50 (32.7%) are 17, and 49 (32.0%) are 18. This indicates that most of the sample comprises students aged 17 and 18, making up more than half of the total sample. Understanding the age distribution is crucial for assessing cognitive styles, as cognitive development can vary significantly across different ages within the teenage years.

Descriptive Analysis

An average of the 15 items' evaluations from each factor was calculated for each participant to generate Verbalizer (V), Visualizer Spatial (VS), and Visualizer Object (VO).

Table 3

Descriptive Analysis Data

No	Code	Description	N Item	N Sample	Mean	Standard deviation
1	V	Verbalizer	15	153	3.3226	.78684
2	VS	Visualizer Spatial	15	153	3.1765	.84204
3	VO	Visualizer Object	15	153	3.6662	.75034

Based on Table 3 above, we can conclude that a total of 15 items from 153 samples on the Verbalizer (V), Visualizer Spatial (VS), and Visualizer Object (VO) variables show averages of 3.3226, 3.1765, and 3.6662 with standard deviations of .78684, .84204, and .75034. The interpretation results show that object visualization is the most prominent ability in the sample, while spatial visualization is the weakest.

Normality Test Result

Table 4

Normality Test Result

No	Code	Description	N	Test Statistic	Sig (*p*)	Normality
1	V	Verbalizer (V)	15	0.141	.095c	Normal
2	VS	Visualizer Spatial (VS)	15	0.159	.094c	Normal
3	VO	Visualizer Object (VO)	15	0.117	.090c	Normal

Table 4 shows that all the variables have normal distribution data. This is because the *p-value* in each variable is more than 0.05, which means that the data is normally distributed.

Correlation Test Result

Correlation test was used to measure the relationship between variables of this research. Researchers employed a correlation test to determine if the study's variables were related (see Table 5).

Table 5

Correlation Test Result

Correlations	Verbalizer (V)	Visualizer Spatial (VS)	Visualizer Object (VO)
Verbalizer	-	0.001	0.434
Visualizer Spatial		-	0.052
Visualizer Object			-

Accordingly, the results of the second research question provide credence to the IDN-OSIVQ. To begin, the IDN-OSIVQ showed satisfactory reliability between administrations of the test. Second, the IDN-OSIVQ's three scales showed satisfactory criterion validity, which is not the case with many prior self-report questionnaires. In particular, participants' evaluations of the object and spatial verbal scales correlated favourably with only the criteria tasks that directly connected to them. Third, a comparison was made between the verbal, object, and spatial dimensions of the three-factor model and the standard two-factor model, which depicts Visual-Verbal cognitive style as a bipolar dimension. Confirmatory factor analysis showed that only the three-factor model could account for the observed data and that its overall fit was far better than the two-factor model's. Additionally, the confirmatory factor analysis revealed negative correlations between spatial and object factors and spatial and verbal factors, implying that spatial imagery style may not be completely autonomous but does show some interference with both object and verbal cognitive styles.

Validity Reliability Test Result

Research Question 1

Table 6

Discriminant Validity for the IDN-OSIVQ items Model 1

	Verbalizer (V)	Visualizer Object (VO)	Visualizer Spatial (VS)
I have a strong proficiency in topics related to spatial geometry. (V1)	0.763	0.037	0.285
I feel my memory consists of schemes or outlines of objects or events, rather than containing details (V10)	0.709	-0.057	0.069
When reading storybooks, I can vividly imagine the events or rooms described in the story in detail (V11)	0.784	0.009	0.227
If asked to choose, I prefer visual arts activities such as drawing over technical work (V12)	0.723	-0.042	0.154
I have a photographic memory; I can recall events as if I were seeing the pictures in a photo. I can remember an event as if I were looking at a photo (V13)	0.813	-0.072	0.267
I can easily imagine and rotate three-dimensional shapes in my mind (V14)	0.730	0.008	0.226
I enjoy looking at pictures filled with vibrant colors and unusual shapes, much like those found in modern art. (V15)	0.761	-0.057	0.243
I find it somewhat challenging to express my feelings through writing (V2)	0.770	-0.086	0.217
If asked to choose, I prefer activities related to	0.799	-0.051	0.198

	Verbalizer (V)	Visualizer Object (VO)	Visualizer Spatial (VS)
technology rather than visual arts such as drawing (V3)			
feel that my verbal abilities support my choice to delve into language subjects related to poetry or prose (V4)	0.739	-0.072	0.172
I'm more interested in architecture than painting (V5)	0.824	-0.021	0.257
When drawing, I enjoy using many bright colors (V6)	0.775	-0.017	0.230
While reading books, I prefer making diagrams and sketches rather than imagining full-color pictures (V7)	0.825	-0.136	0.191
I can create jokes and stories better than my friends (V8)	0.746	0.110	0.348
I feel incapable of writing stories, and I don't like being asked to write them (V9)	0.749	-0.197	0.116
I feel I have excellent speaking and writing abilities (VO1)	-0.097	0.697	-0.010
I don't rely on memory from a single direct experience; instead, I use memory from a combination of direct experiences, which I use to solve similar problems, such as math problems (VO10)	0.054	0.764	0.143
I can describe (remember) my friend's face in detail and clarity (VO11)	-0.029	0.658	0.004
I'm proficient at drawing things related to technology very well (VO12)	-0.170	0.772	0.139
When asked to remember an event, I will use words to describe it rather than using pictures (VO13)	-0.070	0.788	0.184
I can easily remember visual details that others might not be able to. For example, I can remember the color of someone's shirt or shoes (VO14)	-0.065	0.743	0.244
I can easily sketch buildings that I am familiar with (VO15)	-0.052	0.723	0.101
When imagining something abstract, like a building, I only envision a sketch of the building rather than its detailed features (VO2)	-0.111	0.734	0.170
When entering a store I frequent to buy specific items, I can accurately describe the location of the item, the shelf it's on, the arrangement of the items, and other items around it (VO3)	-0.077	0.712	0.027
When reading instructions or assembling items, such as toys, I find it easier to understand text-based instructions rather than instructions in the form of pictures (VO4)	0.097	0.724	0.134
I can vividly and clearly describe things stored in my memory, as if the memory is dancing before me (VO5)	-0.045	0.754	0.135
When explaining something, I prefer to provide explanations in words rather than making drawings or sketches (VO6)	0.014	0.785	0.235
When someone presents arithmetic problems, such as	-0.070	0.709	0.105

	Verbalizer (V)	Visualizer Object (VO)	Visualizer Spatial (VS)
43 plus 32, I can easily solve them without visualizing the problem (VO7)			
I can accurately imagine the size, shape, and color of various objects stored in my memory (VO8)	0.048	0.774	0.217
When reading storybooks, I never imagine or visualize events in the book (VO9)	0.000	0.800	0.148
I have no trouble with geometry material in school (VS1)	0.261	0.100	0.811
I have a visual memory. I can remember visual details of a guest, like what they wore, where they sat, and other details, better than what the guest talked about (VS10)	0.182	0.167	0.785
Sometimes I find it difficult to express what I really want to say (VS11)	0.182	0.121	0.817
I cannot imagine how a three-dimensional object looks when rotated (e.g., 90°) (VS12)	0.278	0.213	0.862
My visual memories seem to come alive in my mind (VS13)	0.219	0.085	0.804
I am confident I can pursue a career in architecture because of my drawing abilities (VS14)	0.163	0.186	0.812
When listening to a radio announcer or DJ, I immediately imagine their appearance, even though I've never met them (VS15)	0.228	0.168	0.824
I'm skilled at playing spatial games involving construction with blocks and paper (such as Lego, Tetris, Origami) (VS2)	0.257	0.069	0.794
Sometimes, my memory is so vivid that it's hard to forget (VS3)	0.249	0.242	0.843
When I close my eyes, I can easily visualize events I've experienced (VS4)	0.224	0.129	0.788
My verbal skills are stronger compared to most people (VS5)	0.172	0.127	0.802
When asked to explain an event or someone, I prefer using words over using pictures (VS6)	0.264	0.237	0.849
I enjoy observing sentence structures (VS7)	0.234	0.210	0.831
It turns out my drawings are more schematic (outlined or rough sketches) than colorful and detailed (VS8)	0.299	0.270	0.851
I enjoy expressing my thoughts in various ways, whether through writing or words (VS9)	0.310	0.268	0.833

Table 6 shows that as many as 45 items from each variable give a number greater than the cross-loading, which is 0.6. However, on items VO1 and VO11, it gives a figure of 0.697 and 0.658, which has a slight difference with the cross-loading value, so this item is said to be invalid.

Table 7
Construct Reliability Model 1

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Verbalizer (V)	0.951	0.956	0.956	0.590
Visualizer Object (VO)	0.944	0.954	0.949	0.553
Visualizer Spatial (VS)	0.966	0.975	0.969	0.674

With a Cronbach Alpha of 0.951 > 0.6, a rho_A of 0.956 > 0.7, Composite Reliability values of 0.956 > 0.7, and an Average Variance Extracted (AVE) of 0.590 > 0.5, the reliability test on RQ 1 reveals that the Verbalizer (V) variable is reliable. This establishes the reliability of the items on variable Verbalizer (V). The items on the Visualizer Object (VO) variable can be stated to be trustworthy, as seen by the following: a Cronbach Alpha value of 0.944 > 0.6, a rho_A of 0.954 > 0.7, Composite Reliability values of 0.949 > 0.7, and an Average Variance Extracted (AVE) of 0.553 > 0.5. Finally, the Visualizer Spatial (VS) variable's Cronbach Alpha, rho_A, Composite Reliability, and Average Variance Extracted (AVE) values are more than 0.6, 0.7, and 0.674, respectively. This establishes the reliability of the entries on the VS variable.

DISCUSSION

This study proposes and tests a new theoretical model of visual-verbal cognitive style using seven different dimensions, including Verbalizer (V), Visualizer Spatial (VS), and Visualizer Object (VO). In addition, this study also introduced a new self-report tool, the IDN-OSIVQ, which has been validated in three trials using this three-dimensional model. Findings show that the IDN-OSIVQ accurately measures the three theoretical constructs (object, spatial, and verbal), thus confirming that these theoretical constructs can be effectively operationalized. The study also found that all IDN-OSIVQ scales had acceptable internal reliability, with principal component analysis showing that items measuring the object, spatial, and verbal constructs loaded on distinct and coherent factors.

Furthermore, the second research question corroborated the convergent and discriminant validity of the IDN-OSIVQ by showing that the pattern of correlations between measures known to be related or unrelated to the object, spatial, and linguistic constructs aligned with theoretical expectations. This indicates that the IDN-OSIVQ reliably measures the three aspects of cognitive style. The study also highlighted that the IDN-OSIVQ verbal scale showed the significant differences based on gender, with women rating spatial imagery higher than men, while women rating object imagery higher than men. After controlling for gender, strong relationships between the various cognitive style ratings and the objective measures corresponding to verbal, spatial and object abilities remained. This study provides a valid new tool for measuring cognitive style and enriches our theoretical understanding of the relationship between various dimensions of imagery and cognitive ability.

The primary purpose of this research was to investigate the relationships between object-spatial-verbal cognitive style, a relatively new theoretical framework (Haciomeroglu & LaVenia, 2017). The confirmatory factor analysis results show that the new three-factor model was far more adequate than the traditional Visual-Verbal two-factor model. Negative relationships between object and spatial factors and verbal and spatial factors were also found in our confirmatory factor analysis, another noteworthy finding. Despite their apparent structural and functional independence, there is evidence of interferences and trade-offs between these systems. In reality, they frequently work together to complete tasks. Al Dahhan et al. (2020) previously showed that rivalry for a few executive resources is the root cause of processing system interference in complicated activities. Lyons et al. (2018) emphasize balancing spatial and object-oriented visual perception. Also, in areas like mathematics and physics, where spatial and verbal processing are complementary but sometimes conflicting, there are situations in which they work hand in hand. As a result, to prevent cognitive overload, people may favour spatial imagery over verbal-analytical procedures. Examples of scientists who preferred spatial or verbal-analytical ways of thinking include Poincare, who relied on textual formulations, and Einstein, who preferred spatial visualisation despite language-learning challenges; both made significant contributions to science (Keogh & Pearson, 2018).

Regarding verbal systems and object images, they seem to support dual information coding rather than compete for the same cognitive resources. Research indicates that dual information coding helps tangible nouns be more easily remembered, and verbal information instantly triggers visual-object imagery (Mealor et al., 2016). Research in neuroimaging has shown that mental images and verbal descriptions share similar brain activations, further demonstrating the close connection between visual processing and language (Dawes et al., 2020).

Some participants (e.g., about 11% of the total RQ 1 participants) scored above average on all three IDN-OSIVQ scales, while others (e.g., 10% of the total RQ 1) scored below average. We found negative correlations between the main and multiple supporting variables. Individual scores on these three dimensions should not be combined (for example, as a ratio or subtraction) but assessed independently, as an individual could score high or low on all three scales. This is because, although there may be tendencies in developing different dimensions of cognitive style, such as object imagination or verbal cognitive style, it is important to consider each dimension separately. The factors influencing the development of a preferred information processing style (object, spatial, or verbal) and the relationship between these styles could be studied in future studies. These factors could include age, gender, differences in experience and training, innate abilities, cultural differences, and different types of training and experience.

Future research should also pursue a deeper dive into the various supporting variables and individual differences in information processing related to the object-spatial-verbal cognitive style dimensions (e.g., holistic vs analytical, dynamic vs. static processing, emotionality vs. rationalism, field dependent vs. field independent, etc.). In earlier conceptions of the classic Visual-Verbal cognitive style component, visualizers traditionally preferred to think in tangible, holistic, and subjective terms (Koć-Januchta et al., 2019; Al Dahhan et al., 2020). On the other hand, verbalizers are said to think abstractly, sequentially, and objectively. However, the current study's findings imply that the previous explanation might not be accurate. All three processing paradigms may support abstract representations. In addition, it may be necessary to revise the earlier statement that verbalizers are sequential-analytical thinkers and visualizers are holistic thinkers. According to recent research (Seah & Horne, 2020), by leveraging spatial relations for component organization and analysis, spatial visualizers typically encode and analyze images analytically, component by component. Object visualizers, in contrast, tend to encode visual images globally as a singular perceptual unit and conduct holistic analyses of them. Although they could be good at using sequential and analytical thinking in verbal areas, it does not mean they can think holistically (Banker et al., 2020).

The IDN-OSIVQ has the potential to be a valuable tool in academic and practical psychological investigations. Specifically, it can be an excellent resource for career counseling and assessment. A recent study by Blazhenkova and Booth (2020) showed that even without formal education, children who excel in science and visual arts exhibit cognitive styles typical of adults in those fields. This proves that cognitive style can begin before a person choses a major or occupation (Ridha et al., 2020). Additional research is needed to explain how verbal, spatial and object-oriented cognitive styles develop alongside maturing visual and language skills. Teachers may find the IDN-OSIVQ helpful in guiding students towards suitable careers, selecting appropriate subject matter, and creating more effective lesson plans (Mega et al., 2021). For example, according to recent research by Tippett (2016) and Gates (2017), object visualizers have difficulty viewing scientific graphs as schematic representations rather than abstract ideas. It is crucial to find students who are good at visualizing objects and provide them with resources and tools to see the relationship between objects and their spatial representations on the spot (Moser et al., 2017).

Identifying each team member's cognitive style and assigning them to the role that best matches their style is critical to team success. For example, a study by Haciomeroglu (2016) showed that teams can be optimally formed based on their members' abilities in object or spatial visualization. IDN-OSIVQ can be a valuable tool for practical settings and psychological research. This tool is believed to investigate object, verbal, and spatial cognitive styles, their relationship, and their growth (Aggarwal et al., 2022). A better understanding of the visual and verbal abilities required for success in different fields can significantly improve career counseling, team building, and training and education practices (Höffler et al., 2017).

Finally, a significant issue with earlier studies on cognitive styles was the discordance between theory and measurement and the absence of any supporting theory. Based on beliefs from contemporary cognitive science, this study lends credence to the cognitive style model that categorizes people's processing abilities into three distinct ways: object, spatial, and verbal.

CONCLUSION

This study significantly enriches our understanding of visual-verbal cognitive style. By introducing and validating a new self-report tool (the IDN-OSIVQ), this research accurately measures the three theoretical constructs: object, spatial, and verbal. The results indicate that the tool has acceptable internal reliability and strong criterion validity, outperforming many previous self-report questionnaires. The study's demographic analysis of the sample, which predominantly consists of female students aged 17 and 18, further underscores the robustness of the findings. Notably, the confirmatory factor analysis supports the three-factor model over the traditional two-factor model, revealing negative correlations between spatial and object factors and spatial and verbal factors, thus providing a more nuanced view of cognitive styles.

The implications of these findings are substantial for both educational and psychological assessments. The IDN-OSIVQ can be a valuable tool in identifying and understanding individual differences in cognitive styles, which can inform personalized learning strategies and interventions. Understanding cognitive style preferences can help educators tailor teaching methods to enhance student learning outcomes. Additionally, the clear distinction between object, spatial, and verbal cognitive styles can guide psychologists in developing more effective cognitive and therapeutic interventions. The demographic composition of the sample highlights the need to consider gender and age in cognitive style assessments, ensuring that the tools and strategies developed are inclusive and effective across diverse populations.

However, the study has some limitations, including a sample predominantly composed of teenagers, which may affect the generalizability of the results. Future research should aim to replicate these findings in more diverse age groups and explore longitudinal effects to understand cognitive development over time better. Furthermore, expanding the sample size and including participants from various educational backgrounds could provide a more comprehensive understanding of cognitive styles. Despite these limitations, this research makes a unique contribution by providing a validated tool that enhances our comprehension of the intricate relationships between different dimensions of cognitive style, paving the way for more personalized and effective educational and psychological practices.

REFERENCES

Aggarwal, I., Schilpzand, M. C., Martins, L. L., WilliamsWoolley, A., & Molinaro, M. (2022). The Benefits of Cognitive Style Versatility for Collaborative Work. *Journal of Applied Psychology*. https://doi.org/10.1037/apl0001035

Al Dahhan, N. Z., Kirby, J. R., Chen, Y., Brien, D. C., & Munoz, D. P. (2020). Examining the neural and cognitive processes that underlie reading through naming speed tasks. *European Journal of Neuroscience*. https://doi.org/10.1111/ejn.14673

Atit, K., & Rocha, K. (2021). Examining the Relations Between Spatial Skills, Spatial Anxiety, and K-12 Teacher Practice. *Mind, Brain, and Education*. https://doi.org/10.1111/mbe.12274

Aydin, Ç. (2020). Gender Differences In Visual Imagery: Object And Spatial Imagery. *Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*. https://doi.org/10.16953/deusosbil.531463

Banker, S. M., Ramphal, B., Pagliaccio, D., Thomas, L., Rosen, E., Sigel, A. N., Zeffiro, T., Marsh, R., & Margolis, A. E. (2020). Spatial Network Connectivity and Spatial Reasoning Ability in Children with Nonverbal Learning Disability. *Scientific Reports*. https://doi.org/10.1038/s41598-019-56003-y

Blazhenkova, O., & Booth, R. W. (2020). Individual differences in visualization and childhood play preferences. *Heliyon*. https://doi.org/10.1016/j.heliyon.2020.e03953

Blazhenkova, O., & Kozhevnikov, M. (2009). The new object-spatial-verbal cognitive style model: Theory and measurement. *Applied Cognitive Psychology*. https://doi.org/10.1002/acp.1473

Bled, C., & Bouvet, L. (2021). Validation of the French version of the Object Spatial Imagery and Verbal Questionnaire. *Revue Europeenne de Psychologie Appliquee*. https://doi.org/10.1016/j.erap.2021.100687

Dawes, A. J., Keogh, R., Andrillon, T., & Pearson, J. (2020). A cognitive profile of multi-sensory imagery, memory and dreaming in aphantasia. *Scientific Reports*. https://doi.org/10.1038/s41598-020-65705-7

Fadillah, A. (2016). Analisis Minat Belajar Dan Bakat Terhadap Hasil Belajar Matematika Siswa. *MATHLINE : Jurnal Matematika Dan Pendidikan Matematika*. https://doi.org/10.31943/mathline.v1i2.23

Gates, P. (2017). The importance of diagrams, graphics and other visual representations in STEM teaching. In *STEM Education in the Junior Secondary: The State of Play*. https://doi.org/10.1007/978-981-10-5448-8_9

Haciomeroglu, E. S. (2016). Object-spatial visualization and verbal cognitive styles, and their relation to cognitive abilities and mathematical performance. *Kuram ve Uygulamada Egitim Bilimleri*. https://doi.org/10.12738/estp.2016.3.0429

Haciomeroglu, E. S., & LaVenia, M. (2017). Object-spatial imagery and verbal cognitive styles in high school students. *Perceptual and Motor Skills*. https://doi.org/10.1177/0031512517698555

Höffler, T. N., Koć-Januchta, M., & Leutner, D. (2017). More Evidence for Three Types of Cognitive Style: Validating the Object-Spatial Imagery and Verbal Questionnaire Using Eye Tracking when Learning with Texts and Pictures. *Applied Cognitive Psychology*. https://doi.org/10.1002/acp.3300

Jofré, J., Fuentes, J., Conrady, Y., Michel, M., Quintana, P., & Asenjo-Lobos, C. (2019). Improving Dental Students Fine Motor Skills by Visualization and Mental Imagery: A Pilot Randomized Clinical Trial. *International Journal of Odontostomatology*. https://doi.org/10.4067/s0718-381x2019000100069

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

Kibar, P. N., & Akkoyunlu, B. (2016). University students' visual cognitive styles with respect to majors and years. *Eurasia Journal of Mathematics, Science and Technology Education*. https://doi.org/10.12973/eurasia.2016.1212a

Koć-Januchta, M. M., Höffler, T. N., Eckhardt, M., & Leutner, D. (2019). Does modality play a role? Visual-verbal cognitive style and multimedia learning. *Journal of Computer Assisted Learning*. https://doi.org/10.1111/jcal.12381

Lyons, I. M., Ramirez, G., Maloney, E. A., Rendina, D. N., Levine, S. C., & Beilock, S. L. (2018). Spatial anxiety: A novel questionnaire with subscales for measuring three aspects of spatial anxiety. *Journal of Numerical Cognition*. https://doi.org/10.5964/jnc.v4i3.154

Marinelli, J. P., Lohse, C. M., Fussell, W. L., Petersen, R. C., Reed, N. S., Machulda, M. M., Vassilaki, M., & Carlson, M. L. (2022). Association between hearing loss and development of dementia using formal behavioural audiometric testing within the Mayo Clinic Study of Aging (MCSA): a prospective population-based study. *The Lancet Healthy Longevity*. https://doi.org/10.1016/S2666-7568(22)00241-0

Mealor, A. D., Simner, J., Rothen, N., Carmichael, D. A., & Ward, J. (2016). Different dimensions of cognitive style in typical and atypical cognition: New evidence and a new measurement tool. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0155483

Mega, C., Canella, A., & Pazzaglia, F. (2021). Stile cognitivo visualizzatore in relazione ad abilitŕ immaginative e spaziali. *RICERCHE DI PSICOLOGIA*. https://doi.org/10.3280/rip2009-001003

Moser, E. I., Moser, M. B., & McNaughton, B. L. (2017). Spatial representation in the hippocampal formation: A history. In *Nature Neuroscience*. https://doi.org/10.1038/nn.4653

Otumfuor, B. A., & Carr, M. (2017). Teacher spatial skills are linked to differences in geometry instruction. *British Journal of Educational Psychology*. https://doi.org/10.1111/bjep.12172

Rahayuningsih, S., Sirajuddin, S., & Nasrun, N. (2020). Cognitive flexibility: exploring students' problem-solving in elementary school mathematics learning. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*. https://doi.org/10.23917/jramathedu.v6i1.11630

Ridha, S., Putri, E., Kamil, P. A., Utaya, S., Bachri, S., & Handoyo, B. (2020). The importance of designing GIS learning material based on spatial thinking. *IOP Conference Series: Earth and Environmental Science*. https://doi.org/10.1088/1755-1315/485/1/012027

Rochester, K. (2020). How to combat "Zoom fatigue" in the workplace. *Business Journal ; Rochester*.

Seah, R. T. K., & Horne, M. (2020). The influence of spatial reasoning on analysing about measurement situations. *Mathematics Education Research Journal*. https://doi.org/10.1007/s13394-020-00327-w

Sigurdardottir, H. M., Danielsdottir, H. B., Gudmundsdottir, M., Hjartarson, K. H., Thorarinsdottir, E. A., & Kristjánsson, Á. (2017). Problems with visual statistical learning in developmental dyslexia. *Scientific Reports*. https://doi.org/10.1038/s41598-017-00554-5

Tippett, C. D. (2016). What recent research on diagrams suggests about learning with rather than learning from visual representations in science. *International Journal of Science Education*. https://doi.org/10.1080/09500693.2016.1158435