

Development and Preliminary Psychometric Evaluation of the WILAP Visual Short-Term Memory and Selective Attention Test

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Abstract

Visual short-term memory (VSTM) and selective attention are closely related cognitive processes involved in the encoding, maintenance, and retrieval of visual information under conditions of limited attentional capacity. Existing cognitive assessment paradigms commonly examine visual memory or selective attention as relatively discrete abilities, with many tasks relying on simplified visual arrays or isolated features. The WILAP Visual Short-Term Memory and Selective Attention Test (WILAP-VSTM-SA) was developed to provide a low-cost, physically administered assessment that combines feature-bound visual memory, serial recall, and resistance to visual distraction. The present study describes the development of the instrument and provides preliminary evidence regarding its face validity, content validity, construct validity, test–retest reliability, alternate-form reliability, and preliminary reference values. The pilot study involved University of Ibadan undergraduate STEM students. Fifteen students participated in face-validity assessment, five content validators evaluated the test, and 20 students participated in the preliminary psychometric evaluation. Face-validity responses produced an index reported as .89, while the content-validity assessment produced an index of .86. Correlation with the Benton Visual Retention Test was positive but nonsignificant ($r = .273$), providing insufficient evidence of convergent validity in the pilot sample. Correlations with the Brief Resilience Scale were also nonsignificant for both VSTM ($r = .423$) and selective attention ($r = .377$). Test–retest correlations were strong for VSTM ($r = .897$) and selective attention ($r = .779$), while alternate-form correlations were .707 and .611, respectively. Preliminary descriptive values were $M = .683$ ($SD = .111$) for VSTM and $M = .716$ ($SD = .107$) for selective attention. Findings provide preliminary evidence of feasibility and temporal consistency but do not establish full psychometric validation or population norms. Larger and more diverse samples, improved parallel-form methodology, item-level analyses, and further convergent and discriminant validity studies are required.

1. INTRODUCTION

Human cognition depends on the capacity to temporarily maintain relevant information while selectively allocating attention to information that is useful for current goals. Two closely related processes involved in this function are visual short-term memory (VSTM) and selective attention. VSTM permits the temporary retention and retrieval of visual information, including shapes, colours, spatial arrangements, and feature conjunctions, whereas selective attention enables individuals to prioritize task-relevant information while suppressing irrelevant input.

The relationship between memory and attention has been emphasized across several influential models of cognition. Early models of memory proposed a role for attention in determining which information enters short-term storage, while contemporary accounts conceptualize working memory as involving interactions between temporarily activated representations and attentional control. Cowan's embedded-process framework, for example, conceptualizes a limited subset of activated information as being within the current focus of attention. The WILAP manual similarly conceptualizes VSTM and selective attention as interdependent processes rather than completely independent cognitive abilities.

Visual short-term memory is particularly relevant to situations in which individuals must retain visual information for brief periods while processing subsequent input. Importantly, visual memory does not necessarily involve remembering isolated features independently. Research on feature binding has demonstrated the importance of maintaining integrated representations of objects and their attributes. Luck and Vogel (1997), for example, demonstrated that visual working-memory capacity is meaningfully related to the number of integrated objects that can be maintained. Subsequent work has further examined the attentional demands associated with feature binding and access to visual working memory.

Selective attention is similarly central to successful visual memory. In complex environments, individuals encounter more visual information than can be simultaneously processed in detail. Attentional mechanisms therefore help determine which information receives priority and which information is filtered or suppressed. The WILAP design incorporates this relationship by requiring participants to remember bound visual features while dealing with potentially interfering information.

1.1 Existing measurement approaches

A number of established cognitive tasks assess aspects of visual memory or attention. The Benton Visual Retention Test (BVRT), for example, involves brief presentation and subsequent reproduction of visual designs and has historically been used to assess visual retention. Other paradigms assess visual working-memory capacity using arrays of coloured objects and change-detection procedures. Selective attention is similarly assessed using tasks such as the Stroop Color-Word Test.

These measures have considerable value, but the developers of WILAP identified a measurement gap concerning the simultaneous assessment of feature-bound visual memory and attentional filtering within a single physical task. The WILAP design therefore combines coloured shapes, increasing sequence demands, serial recall, and distractor selection.

The proposed contribution of WILAP is consequently not that existing visual-memory or attention tests are inadequate. Rather, WILAP provides an alternative task structure intended to examine how visual memory performance occurs under conditions requiring attentional filtering and feature binding.

1.2 The WILAP test

The WILAP Visual Short-Term Memory and Selective Attention Test was developed as a physical, low-cost cognitive assessment. The test uses a specially constructed box resembling a small house, containing compartments or doors through which coloured shapes are presented. The original prototype was developed using cardboard before being redesigned into a more stable cuboid structure and subsequently constructed by a carpenter.

The task requires participants to observe sequences of coloured shapes, retain the relevant information, and reproduce the sequence using a response board. Distractor stimuli are incorporated into the task to require participants to distinguish relevant from irrelevant information.

The instrument therefore attempts to operationalize three related processes:

temporary retention of visual information;

binding of colour and shape features; and

selective processing in the presence of distractors.

1.3 Theoretical framework

The conceptual foundation of WILAP draws from several theories of memory and attention. Particularly relevant are the working-memory framework, Cowan's embedded-processes model, feature-integration theory, and models of attentional filtering.

Feature-integration theory proposes that attention contributes to the binding of individual stimulus features into coherent perceptual objects (Treisman & Gelade, 1980). This is relevant to WILAP because participants are required to remember combinations of colour and shape rather than isolated features.

Similarly, Luck and Vogel's (1997) work suggests that visual working-memory representations can consist of integrated objects. This provides theoretical support for the use of coloured shapes as the basic units of WILAP.

Cowan's (2001) capacity framework further emphasizes the limited number of information units that can be maintained in the focus of attention. WILAP operationalizes increasing memory demand through progressively longer visual sequences.

Finally, research on attention and working memory indicates that attentional control contributes to the filtering and maintenance of visual information. The inclusion of distractors in WILAP was intended to reflect this interaction.

1.4 Purpose of the study

The purpose of the present study was to describe the development of the WILAP Visual Short-Term Memory and Selective Attention Test and provide preliminary evidence concerning its psychometric properties.

Specifically, the study examined:

the face validity of the WILAP;

its preliminary content validity;

convergent validity using the Benton Visual Retention Test;

discriminant validity using the Brief Resilience Scale;

test–retest reliability;

alternate-form reliability; and

preliminary descriptive reference values for the pilot population.

2. METHODS

2.1 Test development

The WILAP test was developed as a physical apparatus containing multiple compartments/doors through which visual stimuli could be presented. The initial prototype was constructed from cardboard. Following refinement for stability and usability, the design was converted into a cuboid structure and subsequently constructed as the final physical test apparatus.

The test employs coloured geometric shapes as the principal stimuli. The stimuli were selected to permit the simultaneous representation of multiple visual features and to require participants to remember feature-bound objects.

The developers intended the stimuli to be visually simple, recognizable, and relatively culturally neutral.

2.2 Test task

During administration, participants were presented with sequences of coloured shapes. The sequence length increased as the task progressed. Participants were subsequently required to reproduce the exact sequence using the response board.

The task therefore required both identification of the relevant stimuli and retention of their feature combinations and order.

Distractor stimuli were incorporated into the response stage. Participants were required to distinguish the target stimuli from irrelevant alternatives.

The manual describes the task as involving increasing sequence demands and distractor exposure. Because some numerical descriptions of the stimulus and distractor counts differ across sections of the original manual, the exact final item specification should be reconciled before the instrument is formally published.

2.3 Participants and sampling

The preliminary standardization sample consisted of undergraduate STEM students at the University of Ibadan. Participants were described as students from Statistics, Technology, Engineering, and Mathematics-related disciplines. The reported age range was 17–25 years, with both male and female participants represented.

The principal psychometric analyses were conducted using **20 participants**.

A separate group of **15 undergraduate STEM students** participated in the face-validity assessment, while **five content validators** reviewed the instrument.

The use of STEM students was justified in the original manual on the basis that their academic activities involve frequent processing of sequential information, problem solving, and filtering of irrelevant information. However, the use of a single university and small sample limits the generalizability of the findings.

2.4 Measures

WILAP Visual Short-Term Memory and Selective Attention Test

The WILAP was the principal instrument under development. The VSTM component was intended to assess accurate recall of feature-bound visual stimuli across increasing sequence demands. The selective-attention component was derived from errors associated with distractor filtering.

Benton Visual Retention Test

The Benton Visual Retention Test was used as a comparator measure for visual memory. The theoretical expectation was that individuals demonstrating stronger visual short-term memory on WILAP would demonstrate better visual retention performance on the BVRT.

Stroop Color-Word Test

The Stroop Color-Word Test was administered as an additional measure relevant to selective attention and interference control. The current manual, however, does not provide a corresponding WILAP–Stroop correlation coefficient in the reported results. Consequently, no numerical Stroop validity result is reported here.

Brief Resilience Scale

The Brief Resilience Scale was used as a theoretically unrelated comparator for preliminary discriminant-validity analysis.

2.5 Face validity

Fifteen undergraduate STEM students completed the WILAP and subsequently responded to questions concerning clarity of purpose, understandability of the instructions, apparent relevance of the task to memory and attention, adequacy of the items, engagement, distractor appropriateness, and suitability of the colours.

Responses were recorded in dichotomous yes/no form. The manual reports a face-validity index of .89.

Because face validity represents the apparent rather than empirical correspondence between a measure and its intended construct, this result is interpreted as evidence of preliminary acceptability and perceived relevance rather than construct validation.

2.6 Content validity

Five validators reviewed the test using a set of dichotomized responses concerning whether the instrument accurately measured what it purported to measure. The reported responses produced an index of .86 in the original manual.

The validators included individuals with psychology and health-related backgrounds. Their assessment was intended to determine whether the test content appeared relevant to the constructs of VSTM and selective attention.

The content-validity procedure provides preliminary expert evidence but should be replaced or supplemented by a more formal content-validity methodology in future validation work.

2.7 Construct validity

Construct validity was examined through convergent and discriminant approaches.

For convergent validity, WILAP-VSTM scores were correlated with BVRT scores. A positive relationship was theoretically expected because both measures involve brief visual encoding, retention, and recall.

For preliminary discriminant validity, WILAP component scores were correlated with Brief Resilience Scale scores. Resilience was selected because it represents a psychological construct conceptually distinct from visual short-term memory and selective attention.

Pearson product–moment correlations were used.

2.8 Reliability

Test–retest reliability

The same participants completed WILAP twice under similar testing conditions, with the two administrations separated by approximately 45 minutes. Pearson correlations were calculated between scores from the two administrations.

Alternate-form reliability

An alternate form of the WILAP was administered to assess consistency across versions. Pearson correlations were calculated between the original and alternate-form scores.

The short interval between administrations and the relatively small sample mean that these results should be interpreted as preliminary estimates of score stability rather than definitive reliability evidence.

2.9 Ethical considerations

Participants were informed about the purpose and nature of the study and provided voluntary consent. The manual reports that the test was administered by psychology students who had been prepared to conduct the assessment professionally and respectfully.

The instrument was intended for research and assessment purposes and was not presented as a stand-alone basis for clinical or educational diagnosis.

3. SCORING

The WILAP scoring system was designed to distinguish memory accuracy from errors associated with attentional filtering.

The manual describes fully correct recall as receiving one point and partial recall as receiving 0.5 points. It also contains an inconsistency in the description of the no-recall score, where no recall is listed as one point despite the subsequent penalty formulation treating no recall as a larger error than partial recall.

Accordingly, the exact scoring algorithm should be finalized and corrected in the definitive test manual before publication.

The original manual additionally proposed a composite score weighted 60% toward memory and 40% toward selective attention.

4. RESULTS

4.1 Face validity

The face-validity assessment involved 15 STEM undergraduates. The original manual reports an overall face-validity index of **.89**, indicating that most participants regarded the purpose, instructions, stimuli, and general task structure as understandable and appropriate.

This result provides preliminary evidence that the test was comprehensible and appeared relevant to its intended constructs.

4.2 Content validity

Five validators participated in the content-validity assessment. The original scoring procedure yielded a reported content-validity index of **.86**.

This finding indicates substantial agreement among the validators regarding the apparent relevance of the instrument. However, because the original procedure used a dichotomous response format and the calculation is not presented using a conventional item-level content-validity framework, the result should be regarded as preliminary.

4.3 Convergent validity

The correlation between WILAP-VSTM scores and BVRT scores was:

$r(18) = .273, p > .05, N = 20$.

The relationship was positive but not statistically significant.

Therefore, the present pilot data **did not establish convergent validity between WILAP-VSTM and the BVRT**.

This finding should not be interpreted as evidence that the two instruments measure entirely unrelated processes. The small sample substantially limits statistical power, and differences in task structure, scoring, feature binding, and attentional demands may also contribute to the observed relationship.

Importantly, this result demonstrates why additional validation using a larger sample and multiple visual-memory measures is necessary.

4.4 Discriminant validity

The WILAP-VSTM score correlated with the Brief Resilience Scale at approximately:

$r = .423, p > .05$.

The WILAP selective-attention score correlated with the Brief Resilience Scale at:

$r = .377, p > .05$.

Neither correlation reached statistical significance.

The original manual interpreted these nonsignificant relationships as evidence of discriminant validity. In the present manuscript, these findings are described more cautiously as **preliminary and inconclusive evidence** because the sample was small and the magnitude of the observed correlations was not negligible.

Future studies should evaluate discriminant validity using larger samples and theoretically unrelated cognitive and psychological measures.

4.5 Test–retest reliability

The correlation between the first and second administrations of WILAP-VSTM was:

$r(18) = .897, p < .01$.

The corresponding selective-attention test–retest correlation was:

$r(18) = .779, p < .01$.

These findings indicate strong positive associations between the two administrations and provide promising preliminary evidence of score stability.

However, the 45-minute interval between administrations is relatively short and may allow memory for task structure or stimuli to influence performance. Longer intervals should therefore be used in future studies.

4.6 Alternate-form reliability

The correlation between the original WILAP-VSTM score and its alternate form was:

$r(18) = .707, p < .01.$

For selective attention, the corresponding correlation was:

$r(18) = .611, p < .01.$

These results provide preliminary evidence of consistency across forms.

However, the equivalence of the alternate form should be examined more rigorously in future work. Parallel forms should be matched in sequence length, difficulty, number of target stimuli, distractor ratio, presentation demands, and scoring structure.

4.7 Preliminary descriptive values

The pilot sample produced the following descriptive values:

WILAP component	Mean	SD
Visual short-term memory	.683	.111
Selective attention	.716	.107

These values are best interpreted as **pilot-sample descriptive statistics rather than population norms**.

The original manual proposed interpreting scores in relation to one- and two-standard-deviation bands around these means. However, a sample of 20 students from a single university is insufficient for establishing normative reference values for Nigerian university students generally.

5. DISCUSSION

The purpose of this study was to describe the development of the WILAP Visual Short-Term Memory and Selective Attention Test and examine preliminary evidence concerning its psychometric properties.

The findings provide encouraging evidence concerning the feasibility of the instrument. Participants were able to engage with the physical task, and both students and expert validators generally viewed the

instrument as understandable and relevant. The reliability findings were also promising, particularly for test–retest performance.

At the same time, the findings do not yet establish the WILAP as a fully validated psychological test. The most important limitation is the small pilot sample. The lack of a statistically significant correlation between WILAP-VSTM and the BVRT is particularly important because convergent validity is central to demonstrating that the instrument measures the intended construct.

5.1 Interpretation of convergent validity

The observed correlation between WILAP-VSTM and BVRT was positive but weak and nonsignificant.

Several explanations are possible.

First, the two tests do not have identical task structures. The BVRT requires visual reproduction of geometric designs, whereas WILAP requires participants to retain combinations of colour and shape and reproduce sequential information in the presence of distractors.

Second, WILAP was explicitly designed around the interaction between memory and selective attention. Consequently, WILAP performance may contain attentional-filtering variance that is less prominent in traditional visual-retention tasks.

Third, the pilot sample of 20 participants provides limited statistical power. A modest association may therefore fail to reach statistical significance even if a relationship exists in the population.

The appropriate conclusion is therefore not that WILAP has demonstrated convergent validity, but that **convergent validity remains to be established in a larger validation sample.**

5.2 Reliability

The reliability findings were more encouraging.

The VSTM test–retest correlation of .897 and selective-attention correlation of .779 suggest substantial consistency across the two administrations. Similarly, alternate-form correlations of .707 for VSTM and .611 for selective attention provide preliminary evidence that performance is reasonably stable across forms.

Nevertheless, the 45-minute retest interval is a limitation. Participants may remember aspects of the task or develop strategies during the first administration. Future work should therefore examine temporal stability over longer intervals, such as days or weeks, while controlling for practice effects.

Future reliability studies should also supplement Pearson correlations with intraclass correlation coefficients because ICCs provide a more appropriate framework for evaluating agreement and consistency between repeated measurements.

5.3 Theoretical contribution

The principal conceptual contribution of WILAP lies in its attempt to combine visual memory and attentional filtering within a single task.

The test uses feature-bound visual objects rather than isolated features and introduces distractor information into the task. This design is consistent with theoretical accounts emphasizing the role of attention in controlling access to working memory and the importance of integrated objects in visual memory.

The test therefore represents a potentially useful alternative to conventional tasks that isolate memory capacity or selective attention.

However, this conceptual novelty should not be confused with established construct validity. The theoretical rationale establishes why WILAP might measure the proposed constructs; empirical validation is required to demonstrate that it actually does so.

5.4 Cultural and practical considerations

A notable practical feature of WILAP is its physical, low-cost format. Unlike many computerized cognitive tasks, the instrument can potentially be administered without specialized computer hardware.

The manual also emphasizes the selection of relatively familiar colours and shapes and identifies cultural familiarity as a consideration in cognitive assessment.

Nevertheless, cultural neutrality cannot be assumed simply because geometric shapes and colours are used. Future validation should investigate whether performance differs systematically according to visual familiarity, colour-vision status, educational background, or other demographic factors.

6. LIMITATIONS

Several limitations should be considered.

First, the psychometric sample was small ($N = 20$), substantially limiting statistical power and the precision of the reported estimates.

Second, participants were recruited from a single university and primarily represented STEM disciplines. Consequently, the findings cannot be generalized to Nigerian university students as a whole or to non-student populations.

Third, the test–retest interval of approximately 45 minutes may permit practice effects.

Fourth, the alternate-form methodology requires further refinement to establish true equivalence between forms.

Fifth, the present study did not establish convergent validity with the BVRT.

Sixth, although the Stroop Color-Word Test was administered as part of the planned construct-validation procedure, the current manual does not report a numerical WILAP–Stroop correlation. This prevents a complete evaluation of the selective-attention component in the current dataset.

Seventh, the current scoring system contains an internal inconsistency concerning the numerical treatment of no-recall responses. This must be resolved before formal publication of the test manual.

Finally, the descriptive values reported as norms were derived from only 20 University of Ibadan STEM students and should therefore be considered preliminary reference values rather than normative data.

7. RECOMMENDATIONS FOR FURTHER VALIDATION

The next stage of WILAP development should involve a larger and more diverse validation study.

A substantially larger sample should be recruited from multiple faculties and, ideally, multiple Nigerian universities. The sample should include sufficient variation in age, gender, educational background, and academic discipline to permit examination of demographic effects.

The revised study should include:

Formal content-validity assessment using item-level relevance ratings.

Item analysis to determine item difficulty and discrimination.

A larger convergent-validity battery, including established measures of visual memory and selective attention.

Explicit analysis of the Stroop relationship with the WILAP selective-attention component.

Discriminant-validity measures that are theoretically unrelated to the target constructs.

Test–retest reliability over a longer interval.

Intraclass correlation coefficients in addition to Pearson correlations.

Properly parallel alternate forms matched for difficulty and task structure.

Analysis of the dimensionality of WILAP, where the final item structure and sample size permit.

Item-level and score-distribution analyses to identify floor and ceiling effects.

Larger normative/reference samples before normative interpretations are introduced.

Assessment of colour-vision and visual-function considerations, given the reliance on colour and visual discrimination.

Cross-validation in an independent sample.

The scoring system should also be finalized before further data collection. The current 60:40 composite weighting should not be treated as an established score unless empirical evidence supports the weighting.

8. CONCLUSION

The WILAP Visual Short-Term Memory and Selective Attention Test represents a novel attempt to assess feature-bound visual memory and selective attention within a single physical cognitive task. Its design incorporates coloured geometric stimuli, sequential recall, and distractor filtering, reflecting the theoretical relationship between attentional selection and temporary visual information storage.

The preliminary study provides encouraging evidence regarding feasibility, face validity, content validity, and score stability. Test–retest correlations were particularly strong for the VSTM and selective-attention components.

However, the current evidence does not justify describing WILAP as a fully validated or normed psychological test. Convergent validity with the Benton Visual Retention Test was not established in the pilot sample, and the sample size limits the interpretation of both validity and reliability estimates.

The most appropriate conclusion at this stage is that WILAP is a **promising preliminary cognitive assessment requiring further psychometric development and validation**. A larger, methodologically rigorous validation study could establish whether its proposed combination of visual short-term memory, feature binding, serial recall, and attentional filtering provides incremental value beyond existing cognitive assessment measures.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical principles concerning voluntary participation, informed consent, confidentiality, and the right to withdraw from the study were observed throughout the research process. All participants were informed about the purpose and procedures of the study before participation and provided informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Olawale Folarin contributed to the conceptualization, development of the WILAP instrument, data collection, analysis, and preparation of the manuscript. Ifeoluwa Fatoye, Praise Babalola, Omolayo Folorunsho, and Faith Oloruntola contributed to the development and evaluation of the instrument, data collection, interpretation of findings, and critical review of the manuscript. All authors read and approved the final manuscript.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Human Ethics and Consent to Participate declarations

Human participants were involved in this study. Participants provided informed consent to participate before data collection.

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