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A STANDARDIZED PROTOCOL FOR THE ASSESSMENT AND COMPETITIVE BENCHMARKING OF VISUOSPATIAL WORKING MEMORY: THE WISDOMX SYSTEM:

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ABSTRACT: This paper presents the WisdomX System, a new, browser centered protocol created to offer a standardized, scalable, and reliable measure of visuospatial working memory. The protocol addresses the ongoing desire for highly accessible yet highly rigorous tools for quantifying cognitive function, especially sequential spatial memory. The fundamental task paradigm involves participants remembering and reproducing a dynamically created 3×3 grid matrix path with perfect accuracy. The instrument runs in two stages: a strictly five second timed encoding phase where a path is explicitly presented visually, then a free running reproduction stage where the individual is asked to recall the pathway with exact fidelity. Difficulty is gradually scaled through an adaptable mechanism increasing pathway length (number of segments) linearly with increasing level. Efficiency is measured with a stringent binary rubric where any error deviating from the correct pathway is enough to cause termination of a given trial. All or nothing criterion guarantees high fidelity memory recall is being measured. Ranking is established through a multi factor algorithm with maximum level scored first, then cumulative number of attempts such that a subtle index of memory capacity is measured alongside a measure of perfor-mance efficiency. A fundamental innovation for the WisdomX System is its coupling with a blockchain enabled network to ensure information immutability with uncompromising data integrity. In this paper, we present the structural framework, procedural methodology, and grading logic behind the WisdomX System such that it becomes a dual usage platform: a serious instrument for cogni-tive science and a standardized venue for international cogni-tive competition.
Keywords: Visuospatial Working Memory; Cognitive Assessment; Standardized Protocol; Memory Competition; Digital Neuropsychology; Psychometric Validity; Adaptive Difficulty Scaling

1. INTRODUCTION

1.1 The Need for Standardized and Scalable Cognitive Assessment Tools

Assessment of human working memory has been a standard part of psychology and neuroscience for centuries (Baddeley, 2003). Traditional tests—such as subtests on the Wechsler Adult Intelligence Scale or the Corsi Block Tapping Test—have produced irreplaceable information but have some inherent limitations to their administration (Egeland, 2015). These standardized tests virtually inevitably necessitate one-on-one proctoring with a trained expert in an expertly controlled laboratory setting, a paradigm that is costly, time-consuming, and difficult to replicate with large heterogeneous samples. As a direct outcome, such research is typically restricted to smaller samples with less generalizability to conclusions. Moreover, subtle differences in score and administration allow experimenter effects to contaminate results with diminished reliability and comparability.

The proliferation of digital technology presents an opportunity to overcome these limitations (Öhman et al., 2021). The WisdomX System has been developed to address this gap by offering a fully automated, browser accessible platform for cognitive assessment. By standardizing stimulus presentation, response capture, and scoring within a digital environment, the system eliminates experimenter induced variability and enables the simultaneous testing of thousands of participants globally under identical conditions. This capacity for mass administration reduces costs and opens the door to large-scale, cross-cultural re-search into visuospatial memory. In effect, a competitive challenge is transformed into a powerful engine for cognitive science, capable of generating vast and diverse datasets that were previously unattainable—thereby democratizing the process of cognitive assessment and research.

1.2 The WisdomX System as a Protocol for Pure Memory Assessment

Major design intent behind the WisdomX System is to isolate and measure one specific cognitive ability: visuospatial working memory with a particular emphasis placed on sequential processing (Piccardi et al., 2023). Being neither developed as a problem game nor a logical or strategy game but a standardized tool for verifying pure memory with homogeneous limitations, participants are neither asked to think a path but to recollect a rigorously pre-visualized path.

Every facet of the paradigm—from minimalist interface to strict timing and binary scoring—is adjusted to minimize extraneous contributions from non-target domains of cognition. Visual environment simplicity ensures that resources will not be expended processing richly complex environments but will be expended instead on storage and recall of sequence of paths. Isolation of target construct is key to validity of the protocol as a psychometric instrument. Elimination of confounds allows a direct and unencumbered measure of an individual's ability to maintain a sequence of spatial information in immediate awareness.

1.3 Framework Overview: A Dual-Purpose System

The WisdomX System is imagined as a twin-purpose platform that combines the rigor of a scientific instrument with the excitement of a competitive sport. On one side, it is a cognitive training device that enables one to practice and possibly improve visuospatial memory with structured, gradually increasing tasks with near-instantaneous feedback. On the other side, it is de-clared a formal competitive discipline—a "brain sport." Rules and structure aim to be official rules for an international championship such that participants everywhere can compete in fair and transparent conditions. Such a competitive framework demands maximum standards of fairness and integrity of data such that these concerns are met through the technological architecture of the system. By putting competition into a properly defined structure with rules, the WisdomX System creates a platform where a person's performance can be measured officially, ranked, and certified such that a valid and globally accepted criterion for excellence in visuospatial memory is created. Accordingly, the system serves both the person interested in cognitive improvement and a global community of cognitive athletes.

2.0 THE WISDOMX SYSTEM TASK PARADIGM: STRUCTURAL AND PROCEDURAL FRAMEWORK

2.1 The Test Environment: A 3×3 Grid Matrix

The cognitive task underlying the protocol takes place within a highly constrained, minimalist setting. The apparatus is a square lattice created by a 3×3 array of squares, establishing 16 discrete nodes (vertices) where the intersections of the gridlines occur. These represent possible stopping/turning points for the path. Pathways consist of segments (edges)—straight lines joining adjacent nodes. Motion is rigorously limited to orthogonal movements (up, down, left, right); diagonal movement is illegal. This is a conscious design decision that diminishes the branching factor for every node such that every step is deterministic and such that encoded information is consistent across trials.

The 3x3 array trades off perceptual sharpness with intellectual challenge. Regularity helps to keep visual search and spatial orientation requirements to a minimum such that restricted encoding time can be committed to learning the temporal spatial order of the observed path. In doing so, a decision is made to support the goal of the protocol to be a pure memory test by managing perceptual confounds and hence boosting construct valid-ity.

2.2 Task Initialization: Randomized Start and End Points

To promote novelty and avoid practice effects from pattern familiarity, a strong randomizing process is utilized for every trial. For a new problem presented to a subject, different start and ending nodes are randomly chosen through a pseudo randomizing algorithm from among 16 available nodes. These are distinctly outlined at the onset of a block-long trial where a start node is utilized as an origin for a path to be found to an ending node acting as a necessary destination.

Randomization is essential to preserve assessment integrity. Predictable or fixed endpoints would invite rote strategies and turn the task into algorithmic problem solving instead of memory recall. In securing that every trial has a new visuospatial sequence, the protocol ensures novel working memory engagement and regularly assesses the ability to encode and recall new information instead of performing stored routines.

3.0 THE TWO-PHASE PROTOCOL FOR MEMORY ENCODING AND RETRIEVAL

Each level's WisdomX System test is comprised of two successive stages: Presentation (Encoding) stage and Reproduction (Retrieval) stage. Such a design mirrors basic memory procedures and allows for extensive analysis for learning with later recall.

3.1 Phase 1: Presentation (Encoding)

Before running a controlled encode trial, participants have a controlled opportunity to encode a target path. At initialization, participants see a correct path from a pre-specified start node to an end node inscribed on their 3x3 grids either with a continuous animation tracing out a route or a static highlight of the individual segments. There is nothing ambiguous about the stimulus that is difficult to perceive.

An important parameter is a fixed five second observation period. Throughout this time, the subject's challenge is to encode the entire path sequence with high fidelity—overall shape, exact order of segments, directionality, and particular nodes passed between. The stiff time constraint is a principal methodological control.

It diminishes compensatory verbal strategies (e.g., subvocalizing "up, right, right, down, left …"), which grow increasingly inefficient with increasing path length. The time pressure tips participants toward the visuospatial sketchpad of working memory (Baddeley, 2003), yielding a purer measure of nonverbal spatial memory—the goal of the protocol. When five seconds is over, the path is eliminated from the screen.

3.2 Phase 2: Reproduction (Retrieval)

Once the encoding stage is complete, the reproduction stage is introduced. The empty 3×3 matrix is again displayed with only the same start node and end node. They have to recall the encoded road from working memory and reconstruct it.

Multiple modalities allow accessibility: participants can draw a freehand line with mouse or touch input or can go into an SAS keyboard mode. Reproduction has to start from a pre-specified start node and end at a pre-specified termination node.

Success requires a perfect, one to one match with the encoded stimulus, meeting three criteria: (1) Sequence—segments drawn in the correct temporal order; (2) Direction—identical directional turns at each node; and (3) Connectivity—traversal through the exact set of connecting nodes. Any deviation consti-tutes an error and invalidates the attempt. This stringent, all or nothing standard enforces high fidelity recall rather than partial recognition.

4.0 DYNAMIC DIFFICULTY ADJUSTMENT AND COGNITIVE LOAD SCALING

A core aspect of the WisdomX System is its deliberate strategy for scaling difficulties to allow pre-cise measurement of visuospatial working memory capacity through predictable, standardized increases in cognitive load.

4.1 Level as a Measure of Path Complexity

For a given framework, Level is determined solely by the length of the path as a function of the number of segments. A higher-level pathway has a longer pathway and therefore a higher working memory demand. As a function of increasing pathway length, an increasing amount of sequential spatial information has to be encoded and retained and thus is found to make the task increasingly difficult.

4.2 The Progression Rule

Difficulty increases with level linearly through a transparent rule:

- level 1 entails recall and memory of a 6 segment course.
- The length of the next stage's course is +2 segments longer than the one successfully passed.

Thus, 8 segments correspond to Level 2, 10 to Level 3, and so on. It is a titration procedure that increases gradually the amount of "items" to be maintained in memory to allow pinpointing an individual's upper limit of error free recall to a controlled level. Level reached effectively is a quantitative measure of visuospatial sequence span that is analogous conceptually to traditional psychometric span tests (Egeland, 2015).

5.0 ASSESSMENT OF PERFORMANCE RESULTS

WisdomX System uses a rigorous objective score rubric that is meant to assess fidelity of memory recall through a binary success/failure paradigm with absolutely no latitude.

5.1 Success Criterion: Perfect Replication

A recall trial is only scored Success if the respondent reproduces correctly the entire path presented to him with 100% accuracy. Reproduction should be identical to stimulus with respect to number of segments, order and direction of segments in time, and exact sequence of intermediate nodes. In case of success, respondent is moved immediately to next level whose length is increased by addition of two segments.

5.2. Failure Criterion: Any Deviation

A Trial is a Failure if it deviates from course outlined in any manner whatsoever, including (but not limited to):

- Drawing the wrong number of segments (too few or too many);
- Making an incorrect turn at a particular node (pre-turn error).
- Mistakingly linking the wrong nodes anywhere in the sequence;
- Not having access to an active node.

This stringent standard prevents partial credit confounds and ensures that the outcome reflects error free retrieval rather than approximate recognition.

5.3 Consequence of Failure: Immediate Trial Termination

At first error, the trial is terminated immediately. Respondents cannot go back, correct errors, or keep guessing. Giving corrections would transform the task from single-store free recall to problem solution or learning by trial and error. Termination immediately after an error guarantees that a successful trial is one single,

continuous, correct recovery of the stored trace, thus maintaining validity for the data collected from the performances. Upon a failure, a competitive run by a participant is over; a new one can commence from Level 1

6.0 A MULTI-FACTOR RANKING SYSTEM FOR COMPETITIVE BENCHMARKING

For overall and impartial evaluation, WisdomX System utilizes a hierarchical multi factor ranking algorithm. In this regard, it considers more than one parameter such that meticulous comparisons of a competitor's intellectual prowess can be performed.

6.1 The Hierarchical Ranking Algorithm

Final ranking is determined by applying the following criteria with their preference order:

1) Major Criterion – Reached Maximum Level. It is largely a criterion of maximum level reached with success, reflective of peak visuospatial working memory capability within WisdomX. A person who reaches a higher level is inevitably ranked higher than a person who is unable to reach.

2) Secondary Criterion (tie breaker 1) – Total Attempts. In the event several participants reach an equivalent maximum level, that one having reached it with a lower total number of attempts is preferred. An "attempt" is an entire sequence starting from Level 1 downwards to failure. It is a measure of efficiency and reliability.

3) Tertiary Criterion (Tie breaker 2). While relative position (e.g., percentile rank) is somewhat de-scriptive, further deterministic tie breakers—e.g., cumulative time spent progressing through successful levels on last attempt—can be utilized if a tie has occurred. In practice, primary criterion and subsidiary criterion take care of most ties. Applying these rules iteratively—first Maximum Level, then Attempts—the resulting final ranking re-wards reliability as much as it rewards capacity.

6.2 Reading the Ranking Metrics

Each standard encompasses a different aspect of performance:

- Maximum Level assesses raw ability, counting how much sequential visuospatial information is stored and reproduced errorlessly with constant restrictions.
- Total Attempts measures reliability and speed. Suppose we have two participants who both reach Level 15. Participant A reaches it after 20 attempts but Participant B after 200. Participant A dominates Participant B even though Participant A has reached the same peak level—exhibiting a higher percentage of successful solutions, fewer low-level mistakes, and quicker learning. It discriminates against "brute force" or "chance" solutions and encourages consistent high accuracy solutions with a better index of real ability.

7.0 PROTOCOL INTEGRITY, DATA PERMANENCE, AND CONCLUDING REMARKS

7.1 Technological Assurance: A Blockchain Network

Integrity is core to a competitive system running online. To minimize risks of data falsification, cheating, and ambiguous record maintenance, the WisdomX System has a blockchain-based ledger for storing data. All critical performance parameters such as maximum level reached, total number of attempts taken, and time data for each individual trial are stored as a transaction in a decentralized immutable ledger.

Blockchain allows for three fundamental assurances:

1) Immutability & Fairness. Written records cannot be modified or removed by a lone entity, including administrators, providing a tamper-proof outcome as well as a fair competitive landscape.

2) Transparency. A decentralized ledger—whether public or permissioned one—allows standalone auditing and verification of ranking data such that standings rely on valid data of performance.

3) Permanence. Distributed storage across multiple nodes preserves the historical record of the champi-onship and protects against single point failures.

This cryptographically secure basis is neither incidental but core to the claim to validity as a formal international competition by the WisdomX System. It ensures reliable certification of success and a robust ranking system that is global.

7.2 Conclusion: Common Framework for Cognitive Science and Sport

The WisdomX System synthesizes rigorous psychometric design with engaging competitive mechanics. Through controlled task parameters, systematic difficulty scaling, and objective, high fidelity scoring, it offers a reliable method for quantifying visuospatial working memory capacity. Framed within a champi-onship structure, it functions as both an effective training tool and a legitimate brain sport. The multi-factor ranking algorithm affords nuanced evaluation, while the blockchain layer provides an unimpeachable basis for trust and integrity.

Consequently, the WisdomX System is proposed as a next generation platform with a twin mandate. To the scientific community, it is a scalable, accessible tool that is able to produce unprecedented amounts of high quality data about human memory so that large scale investigation into cognition becomes possible. To the

international community of cognitive athletes, it is a fair, transparent, and standardized venue for competition where mental ability is honored and performance is measured with assurance.

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