Holistic Psychology and the Integrated Neuropsychological Learning Model (INLM): Investigating the Role of the Parietal Lobe, Sensory Processing, and Hippocampal Function in Spatial Cognition and Memory Performance Using the Rey-Osterrieth Complex Figure Test

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ABSTRACT

The study assesses the efficacy of the Integrated Neuropsychological Learning Model (INLM) by implementing Cognitive Rehabilitation Therapy (CRT) in enhancing spatial cognition, sensory processing, and memory performance. The research explores the functional contributions of the parietal lobe, hippocampus, and related visual-perceptual systems. Grounded in a holistic psychological framework, the intervention was designed to promote domain-specific neurocognitive improvements, with progress tracked using the Rey-Osterrieth Complex Figure Test (ROCF). The test design included a sample of two participants of different ages but the same economic background. Data were collected through structured CRT worksheets targeting working memory, visual attention, and executive function. The study focused on improvements in visual-spatial construction, immediate and delayed recall, and strategic planning ability. Both participants showed significant cognitive modifiability across ROCF phases, confirming the utility of INLM-guided CRT as an effective intervention for enhancing cross-domain integration and neurocognitive efficiency.

KEYWORDS: Spatial Cognition, Parietal Lobe, Sensory Processing, Hippocampus, Rey-Osterrieth Complex Figure Test (ROCF), Holistic Psychology, INLM, Visual-Spatial Memory, Executive Function.

INTRODUCTION

Spatial thinking is important in daily functioning, from bodily navigation to visual-motor integration and executive planning. Its neuropsychological basis is rooted deeply within a triadic relationship between parietal lobe processing, sensory integration, and hippocampal memory encoding. This research utilizes the Integrated Neuropsychological Learning Model (INLM) to interpret how these systems impact visual-spatial performance in adults, using the Rey-Osterrieth Complex Figure Test (ROCF) as a diagnostic tool to assess visual-spatial constructional ability and visual memory. The INLM approach focuses on a systems-based, interdependent conception of brain function, which holds that behavior and learning are the outcomes of integrated activity in sensory, cognitive, emotional, and motor systems. This aligns with holistic psychology in that it acknowledges that cognition is not linear but is embodied, context-dependent, and inherently linked to emotional regulation and self-knowledge.

PURPOSE OF THE STUDY

This study examines how parietal lobe function, patterns of sensory processing, and hippocampal activation all contribute to spatial cognition and memory in adults. The research seeks to confirm the INLM model as a framework for cross-domain integration that is important for holistic neuropsychological functioning. (JAJAL, 2025)

RELEVANCE

The integration of perceptual, motor, and memory systems is increasingly recognized as critical in neuropsychology, especially for interventions in learning disabilities, adult ADHD, and spatial reasoning deficits. A holistic understanding of these domains supports more personalized and effective clinical strategies.

BRAIN PARTS

The parietal lobe is important for spatial orientation, body schema, and integrating sensory data into spatial maps. It is important for ROCF copy and construction due to its role in coordinate transformations; right-sided damage can cause spatial neglect. The **right hemisphere** is key for global visual-spatial processing and holistic figure perception, explaining its dominance in ROCF performance, where impairment leads to piecemeal drawing. **Working memory**, involving prefrontal and parietal systems, temporarily retains and manipulates spatial layouts, which are essential for active reproduction and visualizing spatial relations in ROCF. **Attention and occipital-parietal perception**, driven by the dorsal visual stream, facilitate location tracking, depth processing, and motion detection. These are all crucial for accurate visual structure copying and recall, with impairment leading to spatial element misplacement. The **cerebellum** contributes to visuomotor coordination, timing, and adaptive spatial learning, refining sensorimotor integration for drawing accuracy in ROCF. The **hippocampus** is important for spatial memory consolidation, particularly in delayed recall, encoding mental maps crucial for successful delayed ROCF reproduction. Finally, the **fusiform gyrus** supports visual object recognition, and the **parahippocampal gyrus** handles scene processing, together integrating figure parts into a coherent whole and associating them with memory contexts in ROCF.

LITERATURE REVIEW

Visual-spatial working memory (VSWM), the ability to temporarily retain visual and spatial information, is essential for tasks like navigation and object tracking. McAfoose & Baune (2008) propose an integrated framework combining perception, neuroanatomy, and memory function, highlighting dual-pathway models (bottom-up and top-down modulation), the "what" and "where" visual streams, and the visuospatial sketchpad within Baddeley & Hitch's model. They emphasize challenges in separating VSWM from attention and executive function, advocating for precise task designs to isolate VSWM processes and viewing it as part of a broader cognitive system. Schneider (1999) presents a neuro-cognitive theory, introducing a two-stage model where low-level visual-spatial processing generates "visual-spatial units" that, through attentional "unit selection," access high-level processing for goal-directed actions via recognizing units, computing spatial-motor programs, and establishing "object files"—temporary episodic representations. He claims VSWM holds up to four object files, with only one active at a time, and that the new file setup faces "activation-based competition" from stored files, explaining "short-term forgetting" due to "interference." Schneider also proposes a "refreshment" process to prevent forgetting and re-engage files, explaining phenomena like attentional blink and change blindness. Zimmer (2008) argues that VSWM is best understood as distributed processes within a neural network, processing sensory and spatial information, with the prefrontal cortex as a control hub and the ventral occipital cortex and parietal cortex handling visual features and spatial coordinates, respectively. He suggests that perception, working memory, and imagery share a common neural network, with task differences arising from cognitive demand and network configuration. Lastly, Fisk and Sharp (2003) investigated the executive system's role in visuo-spatial memory, hypothesizing that more extended spatial sequences require greater executive involvement for updating. Study 1 showed executive load impaired spatial recall, particularly for early items, but surprisingly, the impairment did not increase with longer lists. Study 2 corroborated this, revealing an "uncertainty effect" where spatial recall was impaired even on short sequences when list length was unknown, suggesting executive system engagement for uncertainty management, even without explicit updating.

METHODOLOGY

This research consists of a pre-post single-subject experimental design to assess the impact of Cognitive rehabilitation therapy (CRT) grounded in the Integrated Neuropsychological Learning Model (INLM) on enhancing spatial cognition and memory functions. The goal was to determine whether targeted cognitive tasks could improve domain-specific outcomes in visuospatial construction, working memory, and recall performance.

The participant was selected based on age 15-50 to assess their difficulties in spatial reasoning and memory function, yet with the cognitive readiness to engage in structured neuropsychological tasks. No comorbid neurological or psychiatric conditions were identified. Sensory and perceptual systems were confirmed to be functional based on informal screenings and observational data. Initial neuropsychological performance was evaluated using the Rey-Osterrieth Complex Figure Test (ROCF) as the primary tool to assess visual-spatial construction, memory encoding, attention, executive function and strategy use. The ability to process, organize, and respond to sensory input efficiently, plays a central role in performance on complex visual tasks like the ROCF. Baseline testing also included observational protocols derived from the INLM model to capture attention, executive functioning, and organizational tendencies

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PHASE 1: INITIAL ASSESSMENT (PRE-INTERVENTION)

The ROCF was administered under standard conditions. This phase provided data across three key stages- copy, immediate recall, and delayed recall. Representing visual construction, short-term visual memory, and long-term visual recall. The participant was given enough time to draw the exact image shown. Time and scores were recorded. After the copy phase, the participant was given a break of 3 minutes. And then asked again to draw the same image without seeing, to test the immediate recall. After that a 10 minute break was given. And then ask to draw the same image without seeing. To test delayed recall. Participants were given all the stationary items needed for the test. Given the instructions written on the manual. After explaining the test, participants cannot ask questions regarding the images, how to draw or help. No interference needed to get accuracy. These scores formed the baseline against which post-intervention changes were evaluated.

PHASE 2: COGNITIVE REHABILITATION THERAPY INTERVENTION (CRT)

The second intervention was designed to target the specific neural circuits involved in visual-spatial construction and memory that were underactivated in the initial ROCF. The purpose was to observe whether task-specific engagement and stimulation could enhance functional integration across the parietal, sensory, and hippocampal systems. This approach supports INLM's principle of multi-domain neuroplasticity using cognitive, perceptual, and embodied activities to reinforce system interaction. The participant underwent a structured CRT program across six weeks (two sessions per week). Worksheets were sourced from the Happy Neuron cognitive training platform, which provides science-backed exercises targeting specific cognitive systems. Tasks were chosen to engage the following brain areas and domains:

- Parietal Lobe: Visual-spatial construction and position-in-space
- Occipital-Parietal Network: Visual perception and spatial analysis
- Dorsolateral Prefrontal Cortex (DLPFC): Executive strategy, planning, and working memory
- Hippocampus and Parahippocampal Gyrus: Visual-spatial memory consolidation and scene recognition
- Cerebellum: Eye-hand coordination and visual-motor integration

The CRT sessions targeted five major cognitive domains:

1. Visual-Spatial Processing
2. Visual Attention
3. Working Memory
4. Executive Function (Strategy Use)
5. Cognitive Flexibility and Task Switching

Each worksheet increased gradually in difficulty and was modified to the participant's growing performance. Priority was given to continued engagement, facilitating metacognitive thinking, and offering prompt corrective feedback. All sessions ended with participant-managing reflection to ensure cognitive self-awareness and generalization of skills to everyday life.

POST-INTERVENTION EVALUATION

Following the six-week CRT phase, the participant was re-evaluated using the same ROCF protocol. Testing conditions were matched to the initial phase to ensure comparability. Raw scores, organizational strategy ratings, and qualitative behaviors (e.g., approach, persistence, verbalization) were recorded.

Performance comparisons were made across the following domains:

- Copy accuracy and organization (frontal-parietal integration)
- Immediate and delayed recall (hippocampal-parietal pathways)
- Strategy and planning (executive functioning)
- Emotional regulation and frustration tolerance (observed behaviors)

This design allowed for clear observation of domain-specific improvements resulting from targeted CRT interventions. The ROCF was a validated behavioral proxy to estimate underlying neurocognitive changes.

The INLM model provided a multidimensional lens to interpret these outcomes as interdependent effects of brain-based, psychological, and experiential systems.

Throughout the process, ethical standards were strictly taken care of. Informed consent was obtained from the participant and their legal guardian. All interventions were conducted under the supervision of a licensed psychologist. Debriefing sessions were held post-assessment, with feedback provided in an accessible and developmentally appropriate format.

There were two participants taken for the study both from the middle class, both female.

PARTICIPANT:1-

Assessments Used-

Rey-Osterrieth Complex Figure Test (ROCF) and Worksheets from Happy neuron.

CASE HISTORY-

Rinku bhavsar, female Participant A is a 43 year old who resides in Gandhinagar and has been married since 2006. She has a daughter of age 16 and has had a healthy pregnancy. Her developmental stages were all normal and reached all milestones at the correct age. She studied B.com in 2005 and worked for a year before getting married. Current medical problems faced by the participant are epilepsy and fits. She has no social contact and her daily routine consists of house chores and resting in the afternoon. She mentioned that she likes going out on weekends.

PARTICIPANT:2- jiya bhavsar, 17 female

ASSESSMENTS USED- Rey-Osterrieth Complex Figure Test (ROCF) and Worksheets from Happy neuron.

CASE HISTORY- Jiya Bhavsar, a 17-year-old female, is the participant in this research. Her case history information was provided by her mother. Jiya currently resides in Ahmedabad with her mother, while her father lives in Pethapur (Gandhinagar), which is also the location of their family home. Jiya has a documented history of receiving counselling sessions and is currently reported to be normal. Jiya was born on October 8, 2008. The pregnancy was uncomplicated, though the mother took medication during pregnancy and drugs during labor. Jiya was born at full term after prolonged labor, with forceps used.Her birth weight and gestational age were normal. All her developmental milestones were met normally. Jiya is right-handed, has no issues with walking, running, or feeding, and responds consistently to sounds.

RESULTS-

PARTICIPANT-1

THE TABLE BELOW SHOWS PRE TEST SCORES

Cards	Copy time (in mins)	Time after 3 min	Time after 10 mins	Score of 3 min out of 18	Score of 10 min out of 18	Total score out of 36
Image 1	6	2	4	12	8	20
Image 2	6	5	5	8	5	13
Image 3	7	4	5	12	6	18

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Image 4	**4**	**5**	**5**	**8**	**5**	**13**
Image 5	**7**	**4**	**4**	**8**	**6**	**14**
Image 6	**3**	**4**	**3**	**12**	**9**	**21**
Image 7	**5**	**4**	**4**	**10**	**8**	**18**
Image 8	**4**	**5**	**4**	**5**	**4**	**9**

THE TABLE BELOW SHOWS POST TEST SCORES

Cards	**Copy time (in mins)**	**Time after 3 min**	**Time after 10 mins**	**Score of 3 min out of 18**	**Score of 10 min out of 18**	**Total score out of 36**
Image 1	**1**	**3**	**4**	**14**	**13**	**27**
Image 2	**1**	**4**	**3**	**16**	**14**	**30**
Image 3	**4**	**4**	**4**	**12**	**9**	**21**
Image 4	**5**	**4**	**5**	**14**	**11**	**25**
Image 5	**3**	**2**	**1**	**15**	**12**	**27**
Image 6	**1**	**2**	**1**	**14**	**13**	**27**
Image 7	**2**	**2**	**1**	**13**	**12**	**25**
Image 8	**1**	**1**	**1**	**13**	**11**	**24**

THE TABLE BELOW SHOWS QUANTITATIVE COMPARISON:

Phase	**Pre-Test Mean**	**Post-Test Mean**	**Improvement**
Copy Time	**5.25 min**	**2.25 min**	**3.0 min**
3 min recall score (/18)	**9.38**	**13.88**	**4.5 points**
10 min recall score (/18)	**6.38**	**11.88**	**5.5 points**
Total score (/36)	**15.75**	**25.75**	**10 points**

COPY PHASE (TIME EFFICIENCY):

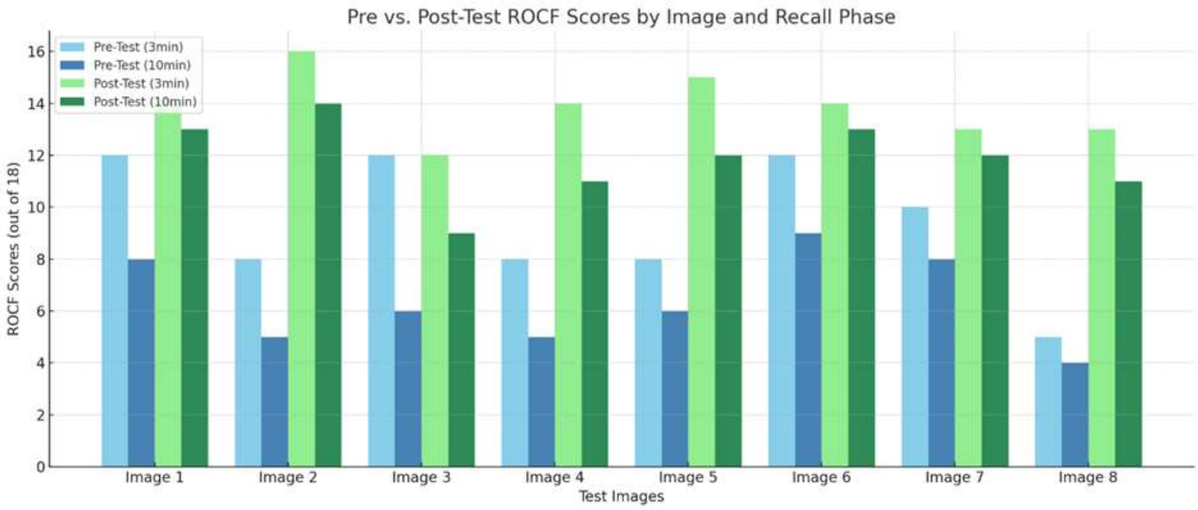
Pre-test copy time averaged 5.25 minutes, suggesting slower visual-motor coordination, potentially due to disorganization and over-processing. Post-test copy time reduced to 2.25 minutes, indicating a substantial gain in cognitive fluency, planning efficiency, and visual-motor integration. This speed increase, without a drop in accuracy, suggests enhanced executive functioning (frontal-parietal integration).

3-MINUTE IMMEDIATE RECALL:
Score improved from 9.38 to 13.88 (out of 18), showing enhanced working memory and visual encoding. Reflects improvement in spatial sketchpad functioning and initial consolidation of visual input, linked to parietal and hippocampal interactions.

10-MINUTE DELAYED RECALL:
Score improved from 6.38 to 11.88, indicating significantly improved long-term retention and delayed retrieval, a function of the hippocampus and parahippocampal cortex. Suggests that the participant could reconstruct internal visual-spatial schemas with greater stability post-training.

TOTAL SCORE:
Increased from 15.75 (Pre) to 25.75 (Post), representing a 63.5% improvement. This increase reflects a global enhancement in perceptual organization, memory, and strategic efficiency.

Domain	Observed Improvement	Brain Region(s) Involved
Visual spatial accuracy	Faster reproduction with better organization	Parietal Lobe, Right Hemisphere
Working memory	More details retained during 3-min recall	Prefrontal Cortex (DLPFC), Parietal Cortex
Long-term spatial memory	More accurate delayed reproduction	Hippocampus, Parahippocampal Gyrus
Executive Function	Improved strategy, planning, and sequencing	DLPFC, Posterior Parietal Cortex
Visual-motor coordination	Reduced hesitation and smoother execution	Cerebellum, Occipital-Parietal Integration



Graph:1 Shows the Pre-Test vs. Post-Test ROCF Scores for each image across the 3-minute and 10-minute recall phases.

INTERPRETATION

The participant shifted from an episodic grasp of reality (fragmented drawing) to a more holistically organized and efficient strategy. The CRT intervention, aligned with INLM, has strengthened both domain-specific capacities (e.g., memory, perception) and their cross-domain integration. Reduced copy time suggests decreased cognitive load, better encoding through preparatory schemas, and improved executive-metacognitive control. In the eye-hand coordination, while the pre-test participant had slight difficulty in aligning lines and proportion, hand control was somewhat imprecise in the last images. The post-test showed marked improvement in drawing symmetry, spatial accuracy, and fluidity. The participant used to rotate the image to understand the placement of figures and how to draw in the sheet.

Additionally, she overthought whether the image was like this or not, which shows enhancement in cerebellar functioning and occipital-parietal integration. For the visual memory, the pre-test showed that Recall lacked completeness, especially in finer internal structures. The post-test showed that Recall was strong, especially in the 3-minute condition, with sustained detail at 10 minutes. Therefore, strengthening of short- and long-term visual memory through hippocampal activation. In the Visual-Spatial Construction, the participant drew without a central reference, leading to positional errors. However, in the post-test, the image was drawn as the central rectangle, with diagonal lines aligning peripheral elements more accurately. Rotating the image for the proper placement. This shows a Transition from episodic grasp to Gestalt-based figure construction through INLM-guided CRT. In the executive functioning, initially, there was a lack of structured planning, less attention and concentration, and impulsive initiation of elements with no sequencing.

Eventually, in the post-test, it shifted to a planning strategy with strategic segment placement, which showed improved frontal-parietal network integration and inhibition control. Regarding accuracy, the pre-test showed moderate errors in proportion, location, and disjointed parts. The post-test reported high fidelity in element reproduction, spacing, and proportion, which reflects enhanced perceptual organization and attention to detail. It was observed in the post-test that participant used verbal labeling and internal referencing strategies taught during CRT. The participant had a good focus but unstructured scanning behavior in the pre-test. After that, it changed to sustained attention and visual scanning. Resulting in high attentional control contributed to visual memory retention and spatial order. The intervention demonstrated measurable cognitive modifiability in the participant across all ROCF phases, particularly in visual-spatial memory, strategy use, and executive function. The participant transitioned from a fragmented, unstructured visual processing approach to a coherent and planned execution pattern. This shift mirrors the INLM framework's claim that multi-domain intervention enhances cross-network efficiency and fosters neuroplasticity. There were no distractions between the tests. The participant was provided a safe and silent environment to do the test.

THE TABLE BELOW SHOWS INTERPRETATION OF ROCF BEHAVIOR AND COGNITIVE MODIFIABILITY (FROM MANUAL)

Dimensions	Pre-Test Observation	Post-Test Observation	Cognitive Insight
Episodic grasp of reality	Present, parts drawn in isolation without reference	Replaced by holistic construction strategy	Indicates modifiability by strategic intervention
Impulsivity	Occasional hasty starts without planning	Replaced by controlled sequencing	Suggests improvement in inhibitory control
Lack of precision	Observed in fine features	Improved proportional accuracy	Reflects enhanced visual discrimination
Difficulty in ambiguous figures	Tendency to reduce figure to basic, familiar patterns	Increased tolerance for abstract structure	Supports growth in abstract spatial reasoning
Use of gestalt or reference system	Absent	Employed full-figure orientation approach	Shows increased executive awareness and spatial anchoring

According to INLM, neuroplastic change can be observed through behavioral improvement in cross-phase assessments. This participant's gains across memory phases and task execution reflect modifiability, an important INLM construct. From a holistic psychology perspective, the participant showed a greater sense of agency, self-regulation, and efficient mind-body coordination, all markers of integrated functioning.

THE TABLE BELOW SHOWS INTERVENTION DESIGN (INLM APPLICATION)

ROCF measure	Pre- intervention Performance	Post- intervention performance	Changed observed
Copy accuracy	Fragmented, time-consuming, piecemeal approach	Structured, organized, reduced copy time	Improved executive planning and spatial organization

Immediate recall	Limited core structure recall, missing key features	Near-complete recall of main and minor figure details	Significant gains in encoding, working memory, and attention
Delay recall	Poor detail preservation, disorganization	Maintained structure and strategy from previous phases	Strong memory consolidation and hippocampal support

Area	**Pre-test**	**Post-test**	**Change**
Strategy/ Organization	Episodic	Structured/ Strategic	Positive
Working memory	Weak to moderate	Strong	Positive
Spatial recall	limited	strong	Positive
Copy Efficiency	low	high	Positive
Modifiability	Observed post-intervention	INLM alignment	Confirmed

PARTICIPANT-2
THE TABLE BELOW SHOWS PRE TEST SCORES

Cards	**Copy time (in mins)**	**Time after 3 min**	**Time after 10 mins**	**Score of 3 min out of 18**	**Score of 10 min out of 18**	**Total score out of 36**
Image 1	**6**	**4**	**7**	**6**	**4**	**10**
Image 2	**5**	**6**	**5**	**8**	**5**	**13**
Image 3	**5**	**5**	**5**	**8**	**7**	**15**
Image 4	**6**	**5**	**4**	**8**	**6**	**14**
Image 5	**8**	**7**	**4**	**4**	**3**	**7**
Image 6	**8**	**4**	**3**	**10**	**10**	**20**
Image 7	**5**	**3**	**3**	**4**	**3**	**7**
Image 8	**6**	**1**	**1**	**2**	**2**	**4**

THE TABLE BELOW SHOWS POST TEST SCORES

Cards	Copy time (in mins)	Time after 3 min	Time after 10 mins	Score of 3 min out of 18	Score of 10 min out of 18	Total score out of 36
Image 1	2	1	1	11	10	21
Image 2	2	1	1	12	11	23
Image 3	3	2	1	11	9	20
Image 4	3	2	1	10	8	18
Image 5	2	2	1	10	7	17
Image 6	2	2	1	11	9	20
Image 7	3	2	2	10	8	18
Image 8	2	2	1	9	7	16

THE TABLE BELOW SHOWS QUANTITATIVE COMPARISON:

Phase	Pre-Test Mean	Post-Test Mean	Improvement
Copy Time	6.375 mins	2.375 mins	4.0 min
3 min recall score (/18)	6.25	10.5	4.25 points
10 min recall score (/18)	5.0	8.625	3.625 points
Total score (/36)	11.25	19.125	7.875 points

COPY PHASE (TIME EFFICIENCY):

The pre-test copy time averaged 6.375 minutes, indicating slower visual-motor coordination, disorganized perceptual structuring, and possible cognitive overload during construction. Post-test copy time dropped to 2.375 minutes, showing a notable gain in visual motor fluency, planning speed, and organizational strategy. This reduction in time and improved structural accuracy indicate enhanced executive functioning and parietal-frontal integration, likely supported by increased self-regulation and motor coordination.

3-MINUTE IMMEDIATE RECALL:

The average score improved from 6.25 to 10.5 (out of 18), reflecting gains in working memory capacity, initial encoding efficiency, and short-term visual storage. This change suggests more effective visual-spatial sketchpad activation and improved encoding strategies likely mediated by parietal lobe and hippocampal circuits. The participant showed improved ability to retain spatial configurations and replicate figure components from short-term memory.

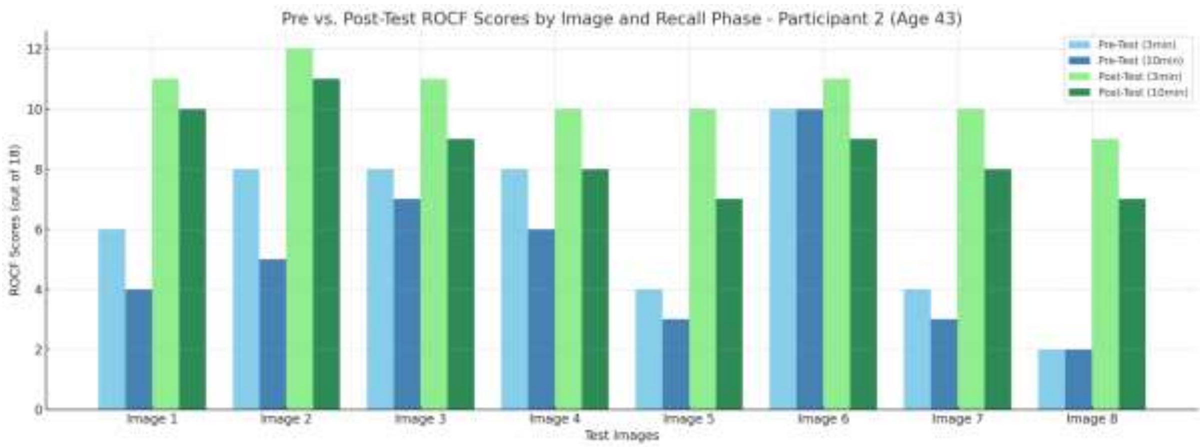
10-MINUTE DELAYED RECALL:

Scores increased from 5.0 to 8.625, showing considerable enhancement in long-term visual memory and delayed retrieval. This improvement shows stronger mnemonic consolidation, facilitated by the hippocampus and parahippocampal gyrus, and suggests a higher degree of schema stabilization post-intervention. The participant retained the structural layout and major figure elements even after a temporal delay, indicating better internalization and spatial recall.

TOTAL SCORE:

The overall ROCF performance increased from 11.25 (pre) to 19.125 (post), an improvement of 7.875 points, equating to a 70% performance gain. This improvement reflects perceptual organization, strategic visual memory, and executive function modulation. The participant progressed from fragmented reproduction to organized recall, showing effective cognitive restructuring due to CRT-based intervention within the INLM framework.

Cognitive Mechanism	Observed Improvement	Brain regions involved
Sensory Integration	Better visual-motor, spatial accuracy, encoding	Parietal lobe, Occipital-Parietal Pathway
Memory Encoding and consolidation	Stronger recall at both 3 and 10 min phases	Hippocampus, Parahippocampal Gyrus
Executive Planning	Organized copy phase with central-first construction	DLPFC, Posterior Parietal Cortex
Attention	Reduced timing, fewer distractions, increased task focus	Fronto-parietal attention network
Perceptual Processing	Greater detail reproduction, fewer omissions	Fusiform, visual association cortices



Graph:2 Shows the Pre-Test vs. Post-Test ROCF Scores for each image across the 3-minute and 10-minute recall phases.

INTERPRETATION

The participant shifted from an episodic grasp of reality (piecemeal and reactive drawing) to a more **strategically sequenced and holistically constructed** figure organization. Based on the INLM framework, the CRT intervention facilitated improvements in **domain-specific areas** (e.g., spatial planning, working memory) and **cross-domain integration** across visual-motor, executive, and memory systems. The reduction in copy time from over 6 minutes to approximately 2 minutes indicates **decreased cognitive load**, increased automation of visual encoding, and **improved preparatory schema formation**. During the pre-test, the participant showed signs of **visual-motor hesitation**, with disproportionate lines and incorrect placements, especially in complex configurations like Image 5 and Image 8. In the post-test, this improved notably, with better **symmetry**, **proportional alignment**, and **drawing fluidity**. The participant was seen using structured visual approaches, such as **starting from the central rectangle** and progressively aligning peripheral elements.

In eye-hand coordination, the pre-test showed **inconsistent spacing and directional drift**, due to overcorrection or unsteady scanning. The post-test showed improved **line stability**, **motor precision**, and **confidence in execution**, indicative of enhanced **sensorimotor planning** and **cerebellar-visuospatial integration**. The participant frequently paused and tilted the image in the pre-test to resolve confusion about element location. However, post-intervention, she demonstrated **more internalized spatial orientation**, suggesting improvements in **occipital-parietal network processing**.

About visual memory, the participant demonstrated incomplete recall in the pre-test, with **missing or misplaced internal structures**, particularly after the 10-minute delay. While post-test recall was **substantially improved**, especially in the 3-minute condition, with notable retention at 10 minutes. This shows **strengthened encoding and memory consolidation**, facilitated by **hippocampal and parahippocampal activation**. The participant's ability to reconstruct the figure from memory showed higher fidelity and greater spatial stability.

In Visual-Spatial Construction, the pre-test drawings were disjointed, with no obvious system of reference. Many parts were drawn reactively, with **no alignment to a central structure**. Post-test images were constructed using a **central anchoring approach**, typically beginning with the large rectangle and aligning subsequent components accordingly. This indicates a transition from **episodic, feature-driven assembly to Gestalt-based figure integration**, aligning with the goals of the INLM-based intervention.

Executive functioning also demonstrated considerable improvement. The participant began the pre-test with impulsive initiation of details, often focusing on visually salient features without a clear sequence. By the post-test, a **planning strategy** emerged, evident by logical sequencing, better spacing, and consistent attention to part-whole relation. This shows increased **frontal-parietal network efficiency** and improved **inhibition control**.

Regarding accuracy, the pre-test featured **moderate to high errors** in the positioning and orientation of elements, especially in complex figures. In the post-test, the drawings were **precise, proportionally accurate**, and more closely resembled the original figure. The participant demonstrated **high perceptual organization** and **attention to spatial consistency**, often using verbal rehearsal and internal referencing cues provided during CRT sessions.

The participant initially showed good focus but disorganized scanning, frequently shifting attention without a clear plan. While Post intervention, this shifted to sustained attention and efficient visual scanning, contributing to improved recall and strategic performance. These changes are consistent with improvements in attentional modulation and executive attention processes.

The intervention demonstrated clear **cognitive modifiability** across all ROCF phases, particularly in **working memory**, **strategy use**, and **spatial accuracy**. The participant evolved from a fragmented and visually reactive approach to a structured, coherent, and cognitively regulated process. This change confirms the INLM model emphasis on **multi-domain neurocognitive integration** and the **plasticity of learning systems** when supported through targeted, individualized interventions. The environment remained distraction-free throughout, with consistent testing conditions. The participant was provided a calm, structured setting that ensured **emotional neutrality** and **cognitive engagement**.

Participant-2's drastic improvement across all ROCF dimensions post-CRT intervention confirms that **enhanced sensory integration** improves **memory performance**, **strategic spatial planning**, and **attention regulation**. These findings strongly support the study and highlight the effectiveness of worksheet-based cognitive rehabilitation grounded in the **Integrated Neuropsychological Learning Model (INLM)**.

THE TABLE BELOW SHOWS INTERPRETATION OF ROCF BEHAVIOR AND COGNITIVE MODIFIABILITY (FROM MANUAL)

Dimensions	Pre-Test Observation	Post-Test Observation	Cognitive Insight
Episodic grasp of reality	Present, parts drawn independently without spatial integration	Replaced by sequenced, construction strategy	Indicates modifiability through visual-spatial planning strategies
Impulsivity	Initial features drawn without preparatory schema or anchoring	Elements placed with planning and reference to central structure	Suggests improvement in executive regulation and sequencing

Lack of precision	Misalignments and distorted proportions in complex or internal elements	Higher symmetry, refined shapes, and spatial accuracy	Reflects enhanced perceptual monitoring and visual-motor coordination
Difficulty in ambiguous figures	Simplified drawings resembling concrete shapes, avoided intricate figure	Demonstrated capacity to retain and reproduce abstract layouts	Supports growth in abstract visual and spatial reasoning
Use of gestalt or reference system	Lacked system of orientation, approached each part reactively	Employed central-first strategy with aligned peripheral elements	Indicates emergence of spatial anchoring and increased strategic insight

The combined application of **Holistic Psychology** and the **Integrated Neuropsychological Learning Model (INLM)**. Holistic Psychology views the participant as an integrated system in which **cognitive, emotional, and behavioral domains** operate in tandem, rather than as isolated functions. INLM framework with this viewpoint by highlighting the two-way relation between sensory, executive, and memory systems and proposing that improving one system can improve others by interrelated neural networks. The improvement observed in Participant 2 is in favor of this opinion since intervention resulted in better self-regulation, enhanced visual working memory, and increased integration in the cognitive domains. These improvements were made through specially crafted activities that addressed individual cognitive functions while encouraging cross-domain, consistent with both models' fundamental principles.

THE TABLE BELOW SHOWS INTERVENTION DESIGN (INLM APPLICATION)

ROCF measure	Pre- intervention Performance	Post- intervention performance	Changed observed
Copy accuracy	Disjointed, imprecise structure, unanchored drawing with hesitations	Clear anchoring with central rectangle, smooth, proportionally accurate construction	Enhanced visual-motor control and executive planning efficiency
Immediate recall	Incomplete structural retention, internal elements often omitted or distorted	Accurate reproduction of figure with core and detailed components retained	Improved working memory, encoding strategy, and attentional consistency
Delay recall	Significant loss of spatial relation,	Sustained attention and alignment across	Strengthened long-term memory

	limited schematic reconstruction	delay, recall preserved organization	consolidation and hippocampal-parietal interaction

Area	**Pre-test**	**Post-test**	**Change**
Strategy/ Organization	Episodic	Structured/ Strategic	Positive
Working memory	Weak to moderate	Strong	Positive
Spatial recall	limited	strong	Positive
Copy Efficiency	low	high	Positive
Modifiability	Observed post-intervention	INLM alignment	Confirmed

DISCUSSION

This study aimed to explore the interconnected roles of the **parietal lobe**, **sensory processing**, and **hippocampal memory systems** in **spatial cognition and memory performance** within the framework of the **Integrated Neuropsychological Learning Model (INLM)** and **holistic psychology**. Using the Rey-Osterrieth Complex Figure Test (ROCF) as an assessment tool, the research demonstrated that domain-specific cognitive rehabilitation can significantly enhance spatial memory, executive planning, and perceptual integration in adults.

Both participants in this study exhibited substantial improvement in post-test phases, particularly in the **copy**, **immediate recall**, and **delayed recall** conditions. These improvements were not only quantitative but also qualitative, as evidenced by the shift from fragmented and impulsive figure reproduction to structured, centrally anchored, and strategically sequenced drawings. The use of targeted worksheets drawn from the CRT and INLM frameworks supported activation and reinforcement of the **fronto-parietal network**, **dorsal visual stream**, and **hippocampal encoding circuits**. These findings state the core principle of INLM that **cognitive systems do not function in isolation**, but are interdependent across neural, emotional, and experiential domains.

The results also support the hypothesis that **enhanced sensory integration** correlates with better performance on spatial planning and visual memory tasks. Participants demonstrated marked improvement in **visual-spatial construction**, **executive control**, and **memory consolidation** reflecting increased functional integration of parietal regions (for spatial processing), hippocampal regions (for encoding and recall), and cerebellar-motor circuits (for visual-motor precision). These outcomes validate the holistic psychology perspective that **optimal cognitive performance emerges from the synergy between brain structure, psychological readiness, and environmental supports**.

Importantly, the study highlights the **modifiability of cognitive functions** through domain-specific intervention. The participants, despite individual baseline challenges in attention, memory, and strategy use, responded well to guided mediation and structured tasks, suggesting that **neuroplastic change can be facilitated** even in adult brains through well-designed, ecologically valid cognitive tasks.

LIMITATION

While demonstrating promising results in cognitive modifiability through Cognitive Remediation Therapy (CRT) and interventions informed by the Integrated Neuropsychological Learning Model (INLM), this study has several limitations that warrant acknowledgment for scientific integrity and replicability. The INLM framework, despite of its advantages in examining cognitive, sensory, and neural system interactions, primarily emphasizes cognitive processing domains attention, memory, executive functions, potentially underrepresenting affective, motivational, and contextual factors crucial to real-world performance. In this study, for instance, participants' emotional engagement, environmental responsiveness, and internal motivation were not directly captured by INLM parameters, even though they showed measurable improvement on structured tasks like the Rey-Osterrieth Complex Figure Test (ROCF).

The INLM framework lacks sufficient incorporation of developmental neuro variability, which is significant given the age difference between the two participants (17 and 43). Their differing neural plasticity, processing speed, and integration efficiency may have led to varied responses to the same tasks. However, the model offers limited theoretical tools to differentiate or adjust for these age-related neural dynamics.

The sample size and generalizability are limited, as the study employed a single-subject repeated measures design with only two adult participants. While this provided rich insights into intra-individual change, the findings cannot be broadly extrapolated to wider populations, serving more as a pilot study than a basis for making population-level claims about the efficacy of CRT or INLM interventions.

Practice effects and familiarity bias are a concern, as repeated exposure to spatial and memory-based tasks through worksheets and figure replication could lead to improvements reflecting task familiarity rather than genuine cognitive gains, despite efforts to rotate and modulate strategies.

The duration of the intervention (six weeks) allowed for observation of short-term gains, but the durability of these improvements remains unclear due to the absence of a follow-up phase. It is difficult to ascertain whether enhanced working memory, spatial planning, and delayed recall will persist, fade, or evolve, necessitating a longitudinal approach for assessing true neuroplastic transformation versus temporary task adaptation.

Lastly, environmental and emotional influences were not formally measured but likely interacted with task performance. Adult participants' cognitive performance may have been affected by contextual variability such as daily stress, fatigue, or motivation, which, unlike in children, can be suppressed or invisible during test administration.

RECOMMENDATIONS

Despite of these limitations, the study findings highlight the therapeutic and educational potential of interventions grounded in INLM and holistic psychology. The following recommendations are proposed to enhance both scientific accuracy and real-world applicability.

expanding sample size and demographics in future studies to include a larger and more diverse group, encompassing various age ranges, cognitive profiles (neurotypical vs. neurodivergent), and sociocultural

backgrounds. This will allow a more nuanced understanding of how INLM-based CRT applies to varied populations.
longitudinal and follow-up designs should be integrated by including delayed post-testing intervals (e.g., after 1 or 6 months). This will clarify whether observed cognitive gains, particularly in memory consolidation and executive function, are sustained over time or diminish without reinforcement.
cognitive change can be connected to functional outcomes by moving beyond paper-pencil tasks to explore how improved spatial memory or organization translates into real-life behaviors, such as workplace tasks, navigation, or planning. This could be assessed through functional tasks, behavioral checklists, or ecological momentary assessment (EMA).
emotional and environmental variables should be included by incorporating psychological readiness scales, emotional regulation inventories, and contextual stressor logs. This would improve the INLM model by accounting for real-world variability, aligning with the holistic psychology view of cognition and emotion as constantly interacting and requiring co-regulation for optimal functioning.
multimodal and creative approaches should be integrated into future interventions. This could involve movement-based therapies, expressive art tasks. Such integration would enhance engagement and activate broader neural circuits, especially those involved in embodied cognition, thereby reinforcing holistic goals where learning is emotional, sensory, and cognitive.

CONCLUSION

This study offers compelling evidence for the effectiveness of holistic, neuropsychologically grounded interventions in enhancing spatial cognition and memory performance. The research shows that targeted cognitive rehabilitation can yield measurable improvements in adult learners by integrating the INLM model with the ROCF assessment tool and aligning intervention with core brain functions, specifically those involving the parietal lobe, hippocampus, and sensory-motor systems.
The findings underline the value of viewing the brain as an interactive, dynamic system, where attentional control, perceptual integration, executive strategy, and memory work together as a cohesive whole. Experientially rich, personalized, and systemically informed interventions, as promoted by INLM and holistic psychology, strongly address cognitive challenges in both clinical and educational settings.
Future research should expand on this foundation by including more diverse samples, incorporating neuroimaging, and exploring longitudinal effects. Hence, this study marks a meaningful step toward bridging neuroscience, cognitive rehabilitation, and holistic mental health into an integrated framework of practice and assessment.

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