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From Model to Method- An Evidence based study. A Holistic Psychological Intervention and INLM based CRT to Strengthen Memory, Attention, and Expressive Language.

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ABSTRACT

The study assesses the effectiveness of Integrated Neuropsychological Learning Model (INLM) through the intervention of Cognitive Rehabilitation Therapy (CRT) on participants while focusing on specific brain facets. The research focuses on evidence based learning and cognitive adaptation.The aim was to enhance memory, attentional control and expressive language with their performance measured through the administration of the multiple test battery of learning disability, Test of memory and stroop test. The test design consisted of a homogeneous sample of 2 participants. The data was collected through test administration and CRT sessions. Participants received specific exercises in working memory, inhibitory control, and expressive language. It also explores various other cognitive domains, as the study is guided through a holistic psychological model and noted the changes in pre intervention scores and post intervention. Both participants demonstrated marked improvements across domains. These results confirm the INLM-guided CRT protocol as a potent, domain-specific treatment for improving neurocognitive abilities.

Keywords: Holistic Psychology, INLM Model, Neuroscience, Neuropsychology, Cognitive Rehabilitation Therapy, Expressive Language, Memory, Attention.

INTRODUCTION

Human beings have a unique capability of higher-order thinking. This thinking arises from active interaction from interdependent processes such as encoding and retrieval of memory, attentional control, elements of working memory, and regulations of emotions. Each mechanism has different functions and a highly integrated neural system. Cognitive neuroscience research reveals these functions are associated with different brain regions. The regulation of emotions is overlooked by the amygdala. This research attempts to tune and intervene in these neuropsychological systems by investigating the impact of a formal **Cognitive rehabilitation therapy** (CRT) program. The study incorporates many test batteries of cognitive and affective tasks designed to challenge the fundamental domains. The study also tries to look into the connectivity and applicability of the **INLM-Integrated Neuropsychological Learning Model.** This framework combines biological, psychological, social and experiential aspects of the learning model.

THEORETICAL FRAMEWORK OF INLM

The theory behind the Integrated Neuropsychological Learning Model states that learning and memory have four **interacting layers**. The neural structures explain that brain areas like the hippocampus, prefrontal cortex, and amygdala are responsible for cognitive and emotional functions. The cognitive process explains the interconnectivity between brain areas and functions like attention, memory, recognition, etc. The psychological elements explain how moment-to-moment tendencies like stress, fatigue, and cognitive readiness affect processing efficiency. At the last, the contextual and experiential factors explain the effect of external sources like task demands, environmental stressors, and interventions like Cognitive rehabilitation therapy. The INLM states a **bidirectional effect** that psychological states can recast neural processing and repeated cognitive practice can produce **neuroplasticity modifications**. Cognitive rehabilitation therapy is predicted to reinforce neural circuits, refining cognitive capacities and thus promoting efficiency in memory and executive functions.

HOLISTIC PSYCHOLOGY

The study is also inspired by the concept of **holistic psychology**. Holistic psychology focuses on individuals as an integrated whole. It has a perspective that sees well-being and performance emerges with **a synergistic fit** between the mind, brain and environment. By incorporating CRT within a holistic context, the study will approach participants as a whole whose brain circuits, and mental states and examine how the environment is shaped by training.

Training in CRT can lead to PFC activation that prepares hippocampal networks for enhanced coding on subsequent repetitions during memory practice. It is predicted that improvements in attention and executive functions will statistically access the declarative recall and pattern separation improvement.

PURPOSE OF THE STUDY

The purpose of the study is to design and assess the effectiveness of a Cognitive rehabilitation therapy program on improving memory and executive functioning among pre-teens. This study will specifically look for the following parts-

- **Memory functions** (immediate recall, story recall, word recall, paired associate learning)
- **Executive functions** (working memory, digit span, inhibition)
- **Language and auditory perception**
- **Emotional understanding and expressive language**

The targeted brain areas are the hippocampus for episodic memory and learning. Prefrontal Cortex for attention, working memory, and cognitive control. **A**mygdala for emotional memory and regulation and Thalamu**s** for sensory processing and attentional modulation

This study will test whether structured cognitive tasks can lead to observable improvement in behavioural measures of improved memory without access to neuroimaging tools by relying on reliable and validated neuropsychological assessments. This will be done through a **pre-post-intervention design**.

RELEVANCE OF THE STUDY

The study is relevant for several reasons. It contributes to the application of behavioural neuropsychology and focuses on cognitive enhancement which can be used in educational programs as well. The intervention is a simple, replicable, and cost-effective tool.

RESEARCH QUESTION

To what extent does Cognitive rehabilitation therapy (CRT) enhance working memory, sustained attention, and executive functioning in children aged 10–14 years. Are these effects moderated by baseline cognitive profiles or duration of intervention?

INTERVENTION

The research intervention inspired by the holistic psychological intervention- demonstrated by the Jalal framework, explains the main domains and the attached core facets from it. They are as follows-

Dimension	**Core Facets**
Cognitive	• Attention & memory retraining (CRT) • Executive-function exercises • Cognitive restructuring (CBT, metacognitive strategies, thought journaling)
Emotional	• Emotion-focused therapy • Emotion modulation) • Self-compassion (mindfulness-based self-compassion)
Behavioural	• Behavioural activation • Habit reversal • Positive reinforcement • Relaxation techniques • Activity scheduling
Physical & Biological	• Sensorimotor psychotherapy • Somatic experiencing • Neurofeedback • Sleep hygiene • Nutritional counseling • Physical activity
Social	• Family systems therapy • Group therapy & social-skills training • Psycho-education • Peer support networks • Community-based rehabilitation
Spiritual & Existential	• Logotherapy & narrative therapy • Existential psychotherapy • meditation & contemplative practices • Yoga & breathwork
Integrated / Interdisciplinary	• Integrative psychotherapy models • Strength-based, person-centred care • Preventive/positive psychology (positive psychotherapy, resilience training)

For this study, the intervention consisted of a structured Cognitive rehabilitation therapy program that was provided to the participants across multiple individual sessions over the internship period. The CRT emphasized the interaction between attention, memory, speed processing and the executive functions of the working memory. The intervention was also informed by the principle of holistic psychology which ensured that the task was emotionally engaging, developmentally appropriate.

Each session lasted approximately 45 to 50 minutes and included the multimodal task which specifically focused on the cognitive domains. Firstly, it included non verbal memory tasks, inhibition training, language expansion exercises. From the above framework, the facets of cognitive, emotional, social and the interdisciplinary tasks were considered. The CRT sessions were adaptive and challenging. The intervention was delivered in a one to one format under guided supervision. After every session, there was performance based feedback, emotional support, and motivational reinforcement consistently.

METHODOLOGY

The research used a pre-post experimental design to assess the efficacy of Cognitive Rehabilitation Therapy (CRT) on enhancing cognitive abilities in a single participant. The treatment was drawn from the InLM model, which targets three specific areas like Information Processing, Learning, and Memory. The participant was included on the basis of average to borderline performance on regular cognitive measures and had no comorbid neurodevelopmental or psychiatric disorders. Sensory function was intact, and the participants showed they could perform task-based interventions with support. Initial cognitive performance was evaluated through a battery of tests. These comprised the NIMHANS Neuropsychological Battery, which evaluated inhibitory control and information processing speed. Also, specialized memory and learning tests which are "Test of Memory for children (Kar et al., 2004) and Test of Learning Disability" It comprises of subtest of Digit Span Test, Word and Story Recall Tasks, and Paired Associate Learning were administered to assess working memory and long-term retention. **Quantitative scores** were generated by each test, supplemented by **qualitative behavioral observations** obtained at testing.

All intervention materials were selected to be available, printable, and affordable, making it feasible to replicate the study in other similar clinical or internship environments. The worksheets employed were modified for the participant's level of cognition and progressively scaled in difficulty as a function of performance feedback over sessions. Each session ended with reflection and feedback to further enhance metacognitive awareness and promote active cognitive engagement.

After the intervention period, the same cognitive test battery was readministered using the same conditions. Pre Intervention and Post intervention performances were contrasted on each cognitive domain. Throughout the process, ethical standards were upheld. Informed consent was initially obtained from the participant and their parents prior to assessment.

Confidentiality was upheld throughout the session under the supervision of professionals. The anonymity of each person was maintained in the strictest sense, and all sessions were run under the supervision of a duly licensed clinical psychologist attached to the clinic. Debriefing followed the post test and was given appropriate and supportive feedback.

LITERATURE REVIEW

1. The Hippocampal–Prefrontal Pathway

Song and others (2013) discuss how the connection between the hippocampus and prefrontal cortex is very crucial for emotions and thinking. This brain link helps with memory, handling emotions, and being flexible with behavior. People struggle with memory and decision-making when this connection gets messed up like from stress, genetics, or brain development problems. They saw this in animal studies and also in humans with disorders like depression, PTSD, and schizophrenia. These people had weaker brain connections in that area, which matched how bad their symptoms were. Also, changes in brain chemicals and signals (like BDNF) were found. This paper highlights that this brain pathway is kind of a fragile spot, where lots of issues can come together, and maybe can try to fix it with things like brain stimulation or targeted meds.

2. Vulnerability and Plasticity of the Prefrontal Cortex Over the Life Course

Mcewen and Morrison (2013) bring together a bunch of studies on rats, monkeys, and people to explain how the prefrontal cortex (PFC) which is needed for memory, decision-making, and self-control keeps changing based on how much stress we go through in life. They explain that stress doesn't just affect emotions, it changes the brain's structure and how it works, especially in the PFC. When stress hits early in life (like during childhood or teenage years), it messes with how the PFC develops. High-stress hormones (like glucocorticoids) can mess up the way brain cells in the PFC grow and connect, leading to problems with focus, memory, and flexibility in thinking. However, the interesting finding is that the young brain can bounce back if the stress stops. So even if things go wrong early on, the brain can recover a lot with time and the right environment.

However, with age, the story changes. With age, the PFC starts to lose its ability to repair itself. The neurons in that area become less complex, they lose their little connection points (spines), and the balance of brain chemicals shifts. so, if stress hits hard when we're older, the brain has a tougher time handling it. It doesn't recover as easily as it did in youth.

3. Working Memory from the Psychological and Neurosciences Perspectives: A Review

Shi et al. (2018) present a detailed and interdisciplinary review of working memory (WM), combining classic cognitive theories with recent neuroscience findings. They bring together models like Baddeley's multicomponent system and Cowan's embedded-processes model to explain how WM works in everyday tasks, basically how we hold on to and use information for short periods. Behaviourally, WM involves handling verbal info (like through the phonological loop), visual-spatial info (visuospatial sketchpad), and using executive control to manage and manipulate that information. Brain imaging and studies on people with brain injuries show that WM relies on a core network, especially the dorsolateral prefrontal cortex (PFC) and posterior parietal cortex (PPC). There are also specific areas in the brain for different types of info like broca's area for repeating words in your head and parts of the visual cortex for mental images. Studies in monkeys show that certain PFC neurons keep firing during delay periods in WM tasks, suggesting this may be how the brain holds onto info actively.

They also mention how these front parietal regions work together through synchronized brain rhythms (like theta-gamma coupling), which helps keep things in memory and focus attention. Developmentally, as kids grow, their WM gets better, which lines up with brain changes like synaptic pruning and more myelination in the PFC-parietal pathways. On the other hand, as people age, WM tends to decline, and that's linked to reduced PFC activity and lower dopamine levels. The paper also discusses how WM problems show up in disorders like schizophrenia, adhd, and depression. In these cases, the PFC networks don't work as efficiently, and neurotransmitter systems (like dopamine) don't function properly. The authors end by saying that to fully understand WM, there is a need to mix behavioral experiments, brain imaging, and computational models. Doing that could help create better interventions to support people with memory-related difficulties.

4. Amygdala Activity and Amygdala–Hippocampus Connectivity- Metabolic Diseases, Dementia, and Beyond

Jung et al. (2023) provide an in-depth overview of how the functioning of the amygdala and its connection with the hippocampus are involved in both metabolic syndromes (like obesity and diabetes) and neurodegenerative diseases (such as Alzheimer's). Using data from previous studies and human brain scans, the review first explains how conditions like high blood sugar, insulin resistance, and abnormal lipid levels can change how the amygdala works. These changes lead to more inflammation and oxidative stress in the amygdala, which disrupt its ability to regulate emotional memory and stress responses. This results in things like stronger fear responses and trouble letting go of fear (impaired extinction).

At the same time, the connection between the amygdala and hippocampus becomes weaker. This weakening is linked to problems with memory and spatial navigation. The authors also explore the biological pathways behind these issues. They explain how problems in insulin signaling within emotional brain circuits and poor blood vessel function can connect body-wide metabolic problems to brain changes. Importantly, the review points out that improving metabolic health through things like eating fewer calories or taking anti-inflammatory medications might help protect the amygdala–hippocampus network and slow down memory decline.

5. Evidence-Based Cognitive Rehabilitation: Systematic Review of the Literature from 2009 through 2014

Cicerone et al. (2019) present an updated systematic review of cognitive rehabilitation (CR) methods used after traumatic brain injury (TBI) or stroke. They analyzed 121 clinical studies published between 2009 and 2014, categorizing them based on how strong and reliable the evidence was (Class I, Ia, II, and III). The review looks at six key areas: attention, visual/neglect issues, language and communication, memory, executive function, and fully integrated programs.

In terms of attention, strong studies (Class I) show that computerized attention training like Attention Process Training can lead to noticeable improvements in both sustained and selective attention for people recovering from TBI. These help people become more aware of space on the neglected side and improve their mobility.

When it comes to language and communication problems after a left-hemisphere stroke, treatments like constraint-induced language therapy and one-on-one speech sessions can be effective, but the strength of the evidence varies. For memory, the authors recommend compensatory techniques such as using memory aids and spaced retrieval; these have been shown to work well and even transfer to daily life tasks, earning them Practice Standard status.

In the area of executive function, metacognitive strategy training which teaches people how to reflect on and adjust their own thinking and behaviour has strong support from Class I and II studies. This type of training helps with planning and goal-setting. For broader cognitive and daily life challenges, comprehensive rehabilitation programs that mix both restorative and compensatory strategies across different skill areas show the most overall benefit, especially when they are done intensively and with a team of professionals.

These focus on making CR plans personalized, starting treatment early, and involving family or peers in the process. Overall, the goal is to help clinicians choose the most effective, research-backed methods to improve both thinking and everyday functioning in people recovering from neurological injuries.

CASE HISTORY

Participant-1 is a 12-year-old who was referred for psychological evaluation because of moderate academic challenges and a learning disability. This was more specific in language-oriented subjects; however, he had adequate mathematical ability. His family is financially moderate, from a lower socioeconomic background. He resides in a nuclear family of four, and his parents are divorced. There is a minimal emotional interaction within the home. His milestones were within limits, with walking at 1.5 years and babbling at 2.5 years. He was born through a normal delivery at 9 months. Although his mother suffered from blood loss in the 8th month. He is typically easy-going and not behaviourally stubborn to an extent. His daily schedule is organized with school, tuition, and a little free time. However, he demonstrated a heavy device use, he is socially active with a lot of friends but only attached to one or two classmates. He exhibits unresolved tense emotional conflicts with his mother. A detailed, interdisciplinary intervention plan is recommended to help his academic, emotional, and social growth. This intervention particularly focuses on testing the effects of CRT on attention and intense memory. Using the Neuropsychological Learning Model (INLM; Jajal, 2025) to support his cognitive and language development is implemented.

Participant 2 is a middle school student who is 13 years old and referred for psychological evaluation concerning language development and general performance. Developmental milestones such as walking and babbling were normal and age-appropriate. His difficulty revolves around areas of language and other learning skills. Both parents are working, and the participant is an only child. There is minimal parental involvement and neglect due to a hectic lifestyle. This can also be a reason for his developmental issues. His day-to-day activities are school, tuition, and a lot of screen time, which is non-educational. There is no extracurricular activity. His diet is normal. The participant is socially shy, reserved, and has limited social contact. His peer interaction is normal. He performs academically at a typical average level, but he has a major problem with language. A detailed, interdisciplinary intervention plan is recommended to help his academic, emotional, and social growth. This intervention particularly focuses on testing the effects of CRT on attention and intense memory.

RESULTS

PARTICIPANT-1

Learning Disability Test

Subtest Code	Area	Pre-CRT Score	Post-CRT Score
I	Eye-Hand Coordination	10/10	10/10
II	Figure Ground	8/10	8/10
III	Figure Constancy	10/10	10/10
IV	Position in Space	9/10	10/10
V	Spatial Reasoning	10/10	9/10
VI	Auditory Perception	6.5/10	7.5/10
VII	Cognitive Ability	10/10	9.5/10
VIII	Immediate Memory	10/10	9/10
IX	Receptive Language	7/10	8.5/10
X	Expressive Language	0.5/10	2.5/10

The above illustration demonstrates the comparative scores of the test of learning disability (NIMHANS) for participant-1, conducted pre and post intervention period.

Memory Test of Children

<table>
<tr><th>Subtest</th><th>Pre-CRT Score</th><th>Post-CRT Score</th></tr>
<tr><td>Personal Information</td><td>5/5</td><td>5/5</td></tr>
<tr><td>Mental Control</td><td><table><tr><td>Time</td><td>Error</td></tr><tr><td>00:04.44</td><td>-</td></tr><tr><td>00:09:91</td><td>-</td></tr></table></td><td><table><tr><td>Time</td><td>Error</td></tr><tr><td>00:03.52</td><td>-</td></tr><tr><td>00:40.72</td><td>-</td></tr></table></td></tr>
</table>

	00:06.40 | - 00:16.42 | 3 00:44.70 | 5	00:05.70 | - 00:24.59 | 3 00:56.38 | 1
Sentence Repetition	5/5	5/5
Word Recall (I)	6/10	6/10
Digit Span	6/15	10/15
Word Recall (II)	6/10	10/10
Delayed Response Learning	6/10	10/10
Picture Recall	3.5/4	4/4
Paired Associate Learning 1	6/10	9/10
Paired Associate Learning 2	9/10	10/10
Paired Associate Learning 3	10/10	10/10

The above illustration demonstrates the comparative scores of the test of Memory (NIMHANS) for participant-1, conducted pre and post intervention period.

Test-3 Stroop Task

Task Description	**Pre-CRT Errors**	**Pre Time**	**Post-CRT Errors**	**Post Time**
Read Non-conflicting Words	0	00:26.66	0	00:23.89
Say Colour (Non-conflicting Words)	0	00:27.19	0	00:19.86
Say Colour (Non-conflicting Items)	0	00:43.68	0	00:29.06
Read Conflicting Words	0	00:19.38	0	00:30.09
Say Colour – Conflicting (Verbal)	8	00:18.71	2	00:38.71
Say Full Colour – Conflicting (I)	1	00:34.16	0	00:40.45
Say Full Colour – Conflicting (II)	0	00:30.21	-	-

The above illustration demonstrates the comparative scores of the Stroop test for participant-1, conducted pre and post intervention period.

PARTICIPANT-2

Learning Disability

Subtest Code	**Area**	**Pre-CRT Score**	**Post-CRT Score**
I	Eye-Hand Coordination	7/10	8/10
II	Figure Ground	2/10	7.5/10

III	Figure Constancy	6/10	10/10
IV	Position in Space	3/10	7/10
V	Spatial Reasoning	7/10	8/10
VI	Auditory Perception	4.5/10	8.5/10
VII	Cognitive Ability	5/10	9/10
VIII	Immediate Memory	6/10	9/10
IX	Receptive Language	8/10	8/10
X	Expressive Language	0/10	2/10

The above illustration demonstrates the comparative scores of the test of learning disability (NIMHANS) for participant-2, conducted pre and post intervention period.

Table- Test of Memory for Children

Subtest	Pre-CRT Score	Post-CRT Score
Personal Information	1.5/5	4/5
Mental Control	3/5	4.5/5
Sentence Repetition	2/5	3/5
Word Recall (I)	4/10	10/10
Digit Span	5/15	7/15
Word Recall (II)	3/10	7/10
Delayed Response Learning	4/4	4/4
Picture Recall	2/4	4/4
Paired Associate Learning 1	3/10	4/10
Paired Associate Learning 2	5/10	6/10
Paired Associate Learning 3	7/10	10/10

The above illustration demonstrates the comparative scores of the test of Memory (NIMHANS) for participant-2, conducted pre and post intervention period.

INTERPRETATION

For participant-1, upon intervention there is a notable score improvement in the expressive language. Even though the expressive language is reported mild due to the evident language barrier, the indicative change does reflect a possibility of neuroplastic change in the frontal language circuits. The improvement is also noted in the digit span and word recall demonstrated enhanced dorsolateral PFC-Hippocampal coordination and manipulation of the information. Delayed response learning and paired association learning also reached a good score which suggested strengthened long term consolidation.

The stroop task times also decreased across all sets and errors. The most challenging condition (set-D) errors dropped significantly. This showcases efficient monitoring in PFC. The CRT intervention targeted the information processing, learning and memory per the INLM, giving measurable improvement in multiple facets. The neurocognitive enhancement does reflect efficient classroom learning and everyday memory functioning.

Cognitive Domain	Neural Structure	Pre → Post (Δ)	Effect	Plasticity Mechanism (INLM Application)	Holistic Interpretation
Digit Span (Working Memory)	Dorsolateral PFC ↔ Hippocampus	6 → 10 (+4)	Positive	dlPFC synaptic strengthening via repeated span practice;	working memory gains indicate successful engagement and plasticity in executive–memory networks
Inhibition (Stroop Errors)	Dorsolateral PFC	8 errors → 2 errors (–6)	Positive	Enhanced inhibitory control through dlPFC network potentiation	Major error reduction reflects strengthened top-down control
Auditory Perception	Thalamus → Primary Auditory Cortex	6.5 → 7.5 (+1)	Positive	Thalamo-cortical synaptic efficacy improved by tone discrimination tasks	Moderate perceptual gain suggests improved sensory relay precision
Expressive Language	Inferior Frontal Gyrus (Broca's area)	0.5 → 2.5 (+2.0)	Positive	Broca's area neural strengthened via verbal fluency and naming exercises	Early language production gains are promising but still low
Immediate Memory	Hippocampus	10 → 9 (–1)	Negative	Short-term CRT insufficient to drive lasting LTP in hippocampal circuits	Slight decline suggests hippocampal encoding/consolidation needs extended or more targeted memory training

The above illustration demonstrates the interpretation of the participant-2 conducted pre and post intervention period.

PARTICIPANT-2

Participant 2 enrolled in the CRT program with significant deficits in processing, cognitive efficiency, and expressive language, though with strong comprehension and delayed-recall skills. During the intervention, they showed significant improvement on figure–ground discrimination and object constancy tasks. Moreover, improvements in working memory capacity and immediate recall indicate more effective dorsolateral prefrontal–hippocampal functioning, and improvements in auditory discrimination infer enhanced thalamic relay and primary auditory cortex processing.

Through the lens of the Integrated Neuropsychological Learning Model, what these alterations show is how specific CRT exercises can co-activate key neural substrates (prefrontal cortex, hippocampus, parietal/occipital cortices) through effectively interesting tasks. Not only does this activation sharpen the cognitive process layer, enhancing attention, memory, and executive control but also the psychological readiness through positive feedback. The comprehensive model emerges in Participant 2's overall cognitive consolidation and enhanced self-efficacy. Thus, it demonstrates CRT's potential as a neuro-informed, multidisciplinary method of cognitive rehabilitation.

Cognitive Domain	**Neural Correlate (Inferred)**	**Pre → Post Change**	**Effect**	**Interpretation**
Visuospatial Skills	Parietal Cortex	Figure Ground: 2 → 7.5Figure Constancy: 6 → 10Position in Space: 3 → 7	Positive	Dramatic gains in perceptual organization tasks suggest enhanced parietal lobe function and spatial reasoning.
Motor Integration	Sensorimotor Networks (Cerebellum / PFC)	Eye–Hand Coord.: 7 → 8	Mild	Modest improvement indicates better sensorimotor coordination, likely via cerebellar–frontal connectivity.
Auditory & Language Processing	Temporal Cortex & Broca's Area	Aud. Perception: 4.5 → 8.5Receptive Language: 8 → 8	Positive / Stable	Significant auditory gains reflect improved thalamocortical relay; receptive language plateau suggests ceiling effect at baseline.
Working Memory & Learning	Dorsolateral PFC ↔ Hippocampus	Immediate Mem.: 6 → 9Cognitive Ability: 5 → 9	Positive	Strong increases in immediate recall and generalized cognition point to strengthened PFC–hippocampal networks.
Expressive Language	Amgydala	Expressive Lang.: 0 → 2	Positive	Emerging expressive skills demonstrate initial plasticity in frontal language circuits; further language tasks recommended.

The above illustration demonstrates the interpretation of the participant-2 conducted pre and post intervention period.

LIMITATION

The intervention based research had many gaps/ limitations. For a study to be scientific, the limitation must be acknowledged to enhance the replicability of the intervention and to assess its effectiveness.

1. **INLM limitation**- the model emphasized on the specific brain behaviour function which may lead to an overemphasis on cognitive domain instead of presenting an integrative view. While the model acknowledges the neuroplasticity, it does not fully include the age related variability in the neural function across the individuals. For instance, in this study the participants differed in their developmental trajectories which may influence the way the brain parts were responsive.
   Moreover, the INL model does not include the contextual or environmental factors which are directly involved in the task performance.
2. **Limited Subject Design**- The study had integrated a limited participant which in a way limits the generalizability of the finding. Even though detailed insights were reported for each session and the progress was noted, the results may not be extended to a broader population.
3. **Possibility of the practice effect or the familiarity bias-** The study had CRT intervention which focused on the repeated exposure of the similar tasks. The improvement on the performance may be due to the familiarity bias with cognitive changes.
4. **Intervention duration**- Even though the sessions for the intervention were observed for shorter duration as well as for the longer duration, the sustainability of the CRT effects can be influenced by the same. This poses a need for a follow up to check the cognitive gains over time.
5. **Environmental and emotional factors**- Testing on children for the developing age of pre-teens may be affected by the testing environment and the external factors associated with it. The external factors such as the child's motivation, emotional state may differ relatively for the intervention days.

Future Implication: Further research should address these limitations by including a larger demographic and a diverse sample. There can also be a longitudinal tracking evaluation to assess the long term impact of CRT on world functioning.

RECOMMENDATION

Although the study has encouraging results, particularly in the areas of working memory, attention, and emotion there are some suggestions to make both the strength and the real-world applicability of this intervention model even greater. Firstly, the study could use a larger and more diverse sample size to determine the actual effect of CRT. This would serve to strengthen the causal understanding of the results. A follow-up along a **longitudinal perspective** (perhaps after 1 or 3 months) would be necessary to determine if gains made in memory or executive function are maintained across time. Also to see if they are lost after termination of therapy. This also includes having a delayed-recall version of tasks is useful in monitoring consolidation better.

There is also a requirement to **imply the neuropsychological grades to more functional and academic outcomes**. With this, the intervention will also be benefitted through parent and teacher ratings, classroom observation, and self-regulation rating scales. This will help in determining whether gains are generalizing to real-world settings such as school or social situations. Lastly, the intervention could explore multimodal approaches such as integrating CRT with emotional regulation modules, movement-based tasks, theatre, or expressive art techniques. This would create a more holistic and layered intervention model that doesn’t only target cognitive circuits but also works with emotional readiness, motivation, and engagement.

CONCLUSION

The current research sought to assess the efficacy of a systematic Cognitive Rehabilitation Therapy (CRT) treatment based on the Integrated Neuropsychological Learning Model (INLM) and holistic psychology principles. Through the influence on cognitive areas like memory, attention and executive functions- the CRT strategy works on to improve neurocognitive results in preadolescent students.

The outcomes of participants revealed significant gains in several domains following intervention, particularly in working memory (Digit Span, Word Recall), long-term consolidation of memory (Paired Associate Learning, Delayed Response Learning), inhibitory control (Stroop Task), and expressive language. These improvements signify activation and refinement of the concerning neural circuits, most specifically the prefrontal cortex, hippocampus, amygdala and working memory.

These results confirm the hypothesis that directed CRT. That, in its form as directed by neuropsychological principles and contextualized by holistic methods, can lead to result in quantifiable gains in cognitive function, even within brief intervention windows. The research provides preliminary evidence for CRT as a replicable, cost-effective, and scalable method for cognitive rehabilitation of learning-impaired children.

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