

A theoretical analysis on existing cognitive rehabilitation models.

Pulari C*, Milu Maria Anto

Department of Psychology, Prajyoti Niketan College, University of Calicut, Thenhipalam, Kerala

Abstract

Background: Cognitive Rehabilitation has been variously used in the research literature to represent non-pharmacological interventions that target the cognitive impairments with the goal of ameliorating cognitive function and functional behaviors to optimize the quality of life. Along with adult's cognitive impairments, the need to address neuropsychological impairments and acquired cognitive impairments among child populations is inevitable.

Methods: All published rehabilitation models and interventions etc targeting the cognitive domains of attention, memory and/or executive function and behavioral aspects that could be identified were reviewed. Based on a systematic review of the literature from (1978-2011) different cognitive rehabilitation models are briefly described. Clinical and research gap in the area are discussed.

Results: 15 papers, both Indian studies and foreign publications (Delhi psychiatry journal, APA PsyNet, Springer, Mount Sinai Journal of Medicine), were identified.

Conclusions: A very limited number of studies in India have done research in the implementation of a structured module for CR, not established yet among children. The review of the current evidence regarding the failures and successes of cognitive rehabilitation among adults shows that several promising approaches have been developed in the last 30 years. Providing at this time is a minimal conclusive evidence for, the efficacy of cognitive rehabilitation in children with developmental cognitive impairment/ acquired brain injury, has been studied. However, a clear need to address the concern of a developing child-based cognitive rehabilitation plans/modules are necessary for creating changes in clinical practice for the child's betterment.

Keywords: Cognitive rehabilitation, Cognitive functions, Neuroplasticity.

Accepted on 02 December, 2021

Introduction

In broad terms, rehabilitation principally focuses on the enhancement of human functioning and quality of life. In contrast, other branches of health care focus primarily on prevention and treatment of disease. Rehabilitation accepts the complex correspondence between disease and the ability to function: a disease may be eradicated while disability remains; disability can be reduced in the face of permanent injury or chronic disease.

The terms cognitive rehabilitation, cognitive remediation, and Cognitive Re-training (CR) have been invariably used in the research literature to represent non-pharmacological interventions that target the cognitive impairments with the goal of ameliorating the same and more importantly, improving functional behaviors to optimize the quality of life. The genesis of cognitive intervention programs can be traced to the World War I and II when soldiers suffered gunshot wounds resulting in traumatic brain injuries [1].

As with physical rehabilitation, cognitive rehabilitation may include interventions that aim to lessen impairments, or interventions that aim to lessen the disabling impact of those impairments. Interventions are applied mostly through technology and other compensatory strategies that may allow the individual with cognitive impairment to accomplish important life activities and more fully participate in society [2]. The intervention and support procedures include:

Attention, Memory and Memory Problems, Retrieval, Organization, Problem Solving, Concrete Versus Abstract Thinking, Instructional Routines, Executive Function/Self-Regulatory Routines, Transfer of Training, Cognitive and Learning Strategies, and others. Models of cognitive functioning like language, reading, memory, attention, and perception have proved useful in rehabilitation [3].

Different definitions have been considered by many researchers on Cognitive Rehabilitation. Few favorable definitions have listed below:

Brain injury association of America

“Cognitive rehabilitation is a systematically applied set of medical and therapeutic services designed to improve cognitive functioning and participation in activities that may be affected by difficulties in one or more cognitive domains. Cognitive rehabilitation is often part of comprehensive interdisciplinary programs” [4].

U.S. veterans administration (VA)

“Cognitive rehabilitation is one component of a comprehensive brain injury rehabilitation program. It focuses not only on the specific cognitive deficits of the individual with brain injury, but also on their impact on social, communication, behavior, and academic/vocational performance [5]. Some of the interventions used in cognitive rehabilitation include modeling,

guided practice, distributed practice, errorless learning and direct instruction with feedback, paper-and-pencil tasks, communication skills, computer-assisted retraining programs, and use of memory aids. The interventions can be provided on a one-on-one basis or in a small group setting”.

CR (retraining, training, revalidation) has become increasingly popular in the eighties. There have been many attempts to create training techniques and supporting theoretical models to improve the cognitive functioning of the patients with chronic brain injuries [6].

Previously some researchers have argued that cognitive neuropsychology lacks an adequate theory of rehabilitation capable of providing a general guide for effective and functionally relevant treatment [7]. Later many researchers have attempted to consider and develop new or adapt existing methods that allow improving cognitive skills of an individual. CR is a field-theoretical base, incorporating frameworks, models and methodologies from number of different fields. Here the rehabilitation is a partnership between patients/clients, families and health service staffs [8].

“Theoretical models of CR vary along several different dimensions. Treatments may be process specific, focused on improving a particular cognitive domain such as attention, memory, language, or executive functions. Alternatively, treatments may be skill-based, aimed at improving performance of particular activities [9].

During the 20th century Luria (1963) is regarded as a pioneer in cognitive rehabilitation. He introduced a “syndrome analysis” which tried to objectify different symptoms in order to find the underlying factors that cause some functional deficits. The basic assumption of syndrome analysis is to correlate mental function disturbances with changes in functioning of a particular neural mechanism [10]. Luria paid attention to the fact that mental functions can be disturbed differently when different brain regions are impaired, suggesting different roles in supporting that mental activity. Disturbance of the same function may be seen when different brain areas are damaged. Luria believed that in order to establish a correspondence between symptoms and lesion localization it is imperative to use “qualitative symptom analysis”, i.e. “detailed analysis of the psychological structure of the disturbance” [11].

The relationships between different cortical functions are explained by means of Luria's theoretical model. In the model, three units were considered and these units were located in specific brain structures. Unit I: brain stem, diencephalon, and mesial regions of the cortex [12]. Unit II: “lateral regions of the neocortex on the convex surface of the hemispheres, of which it occupies the posterior regions, including the visual (occipital), auditory (temporal), and general sensory (parietal) regions”. Unit III: “anterior regions of the hemispheres, anteriorly to the precentral gyrus”. The clinical findings as well as the results of data analysis form the basis of the applied rehabilitation strategies [13].

In conjunction and further to Luria’s model, Pena-Casanova (2018) revised the model to a new functional brain model of five units, delineated as: Preferential (unit for life-support and arousal regulation), Limbic (unit for valuation/motivation and for context memory), Cortical and thalamic- cortical (“the conscious agent”), Basal ganglia (“the reinforcer”), and Cerebellar (“the supervisor”) [14].

More recent researches/publications found that the brains physical structure and functional organization can and does change in adults; this is a concept called “Neuroplasticity or brain plasticity”, which refers to the capacity of the central nervous system to modify its structure and function by altering the neural pathways and synapses dependent on, changes in one’s behavior, environment, thinking or emotions [15]. Plasticity occurs throughout life, albeit critical periods of brain plasticity are the periods in which the developments of brain functional properties are strongly dependent [16]. This greater dependency in young brain happens due to mechanisms of myelination, creation and sprouting of neural projection essential for brain development and modeling of cortical neuronal circuitries. Hence, the maturing brain will shape the cognitive functions in accordance with the experience and environmental stimuli [17].

Studies have reported that high levels of stimulation and numerous learning opportunities at the appropriate times lead to an increase in the density of neural connections [18]. Psychologically, brain plasticity supports CR approaches to use the potential of the brain to change and adapt, thereby helping to restore the lost functions. This permeates us to an understanding based on current theories, that a more plausible approach of the CR distinctively among children would be more conducive and have a far more effective outcome relative to the adult brain [19].

Literature Review

Applied CR

CR is used within multiple professional disciplines, including clinical psychology, neuropsychology, speech-language pathology, occupational therapy, physical therapy, and psychiatry (i.e., rehabilitation medicine) [20]. Collaboration with academic colleagues in other disciplines such as cognitive psychology also occurred. The various disciplines share a common goal of restoring function in a cognitive domain or set of domains or teaching compensatory strategies to overcome domain specific problems, improving performance of a specific activity of daily living. As adult rehabilitation are being focused more in the field of research and practice; the need to address neurodevelopmental impairments (like ADHD-attention deficit hyperactive disorder, ADD - Attention deficit disorder, Specific learning disability and others) and acquired cognitive impairments (due to TBI, seizure disorders, cancer, congenital heart diseases and others) has been increased among child population [21].

Currently in India such multi-disciplinary collaborative approaches have been initiated across the clinical settings but,

most published researches and current clinical practice are predominantly rehabilitating cases like, acquired brain injuries (TBI, Stroke, dementia, neuro-psychiatric disorders) among adults and very few among children [22]. The reviews of the current evidence regarding the failures and successes of cognitive rehabilitation in adults (mostly in the area of attention, memory and executive function enhancement) shows that several promising approaches have been developed in the last 30 years [23].

Here the aim of the paper is to theoretically define the term CR, to review the existing models of CR being practiced (specifically in children) during the period of 1978-2011 and to find out the literature gap in the respective area. The current study recognizes the need to situate more researches on applied cognitive rehabilitation among children. Consequently, the Researcher sets out to collect and collate the above aforementioned information [24].

Theoretical models of cognitive rehabilitation/retraining

Cognitive rehabilitation should be grounded in theory. Different models of CR has been presented to enable the elaboration of an appropriate approach for the chronic psychiatric patient and to bring about observable change in behaviour and level of functioning within the limits given by the psychotic defect and/or brain dysfunction [25]. The basis of this model is the brain- behaviour frame of reference. The essence of this approach is to indicate the actual level of cognitive functioning of the individual patient in terms of an individualized skills profile derived from test results assessing various cognitive functions [26].

Discussion

Researcher has tried to gather many different theoretical models from already existing literature reviews for this study. A few important ones include:

Descriptive (procedure, transcript) models /DM

The following detail on the early connectionist research demonstrates the simple networks trained on unstructured tasks can, when retrained after damage, exhibit rapid recovery on treated items and generalization to untreated items. As such, remedial strategies focus upon ameliorating individual test-specific deficits. Although therapy emphasizes specific deficits, generalized cognitive/neuropsychological improvement is hypothesized to occur. Here the basic approach to rehabilitation, centers around the patient's performance on neuro-cognitive measures and expecting the generalization to untreated items [27].

In addition to Luria's "syndrome analysis" another similar descriptive model of CR was developed derived from the concepts of clinical neuropsychology. Diller starts with identifying test specific approach and then specific task are used that appeals to the respective abilities of a patient and the stimulus reactions qualities to the task were analyzed.

Based on the Activities of Daily Life (ADL) the ability and the task are evaluated, the achievements on other tasks that may reveal abilities associated with the trained ability and with neurological correlates. Consequently a rehabilitation diagnosis is formulated which forms the base of the training process [28].

Information Processing (Analytical) Models /IPM

In the recent years, information theory has been adopted as a basis of cognitive rehabilitation models. Attempts are made to integrate information theory with the neuropsychological frame of reference. Reitan and Wolfson (1985, 1988) gave a model with three levels of information processing based on the following principles:

- Principle of functional specificity: The first level implies attention, concentration and memory
- Principle of functional hierarchy: The second level reflects the lateralized processes, i.e. verbal and language skills in the left hemisphere and spatial and manipulative skills in the right hemisphere.
- Principle of training circuits (tracks): The highest level of information processing is considered as the central one, enhancing abstraction in the form of concept formation, reasoning and/or logical.

Bracy (1986) was influenced by the theoretical formulations of Luria. He tries to operationalize Luria's three functional units in terms of locations and different cognitive processes which are considered typical for a specific functional unit. He suggests, the basic processes must be first trained before, the specific and the then more complex processes can be trained for [29].

Stimulus organism response contingency consequence (SORKC) model

The SORKC model of behavioural psychology is considered to be of great importance in CR because it allows incorporation of physical as well as of neurological status of the individual along with motivation, emotion, behaviour. Stimulus (S) refers to antecedent events, Organism (O) refers to person's biological conditions and individual differences resulting from previous experiences. Response (R) is for the behaviours (motor, cognitive or physiological) that are of concern, Contingency (K) refers to schedules of reinforcement in operation and Consequence (C) refers to events that follow behaviour (physical, social or self- generated) [30].

Model of rehabilitation can best be characterized as behavioral engineering, where the patient's impairment is defined in terms of operationalized behavioral deficits inherently assumed to be maintained by environmental conditions. Therefore, the major objective in treatment is to identify and systematically modify the environmental antecedents that are assumed to underlie the problem behavior. A second basic approach to cognitive rehabilitation by focusing upon groups or patterns of behaviors was also considered in the same year. Subsequently, Wilson and O'Leary (1980) utilized a number of common behavioral analytic techniques, while others like Reitan (1985) and

Wolfson (1988) even introduced theoretical explanation based on the conceptual model of behavioral correlation with brain function.

To this end, unlike "psychometric" model of rehabilitation, behavioral deficits are treated as parts of a whole rather than as individual dysfunctions, with one of the major tasks of the therapist in this approach being to identify the specific components of a stimulus that contributes to the deficit. Moreover, proponents of this model of cognitive rehabilitation argue that these stimulus alterations may bring to the attention of the patient both the nature and extent of his or her disabilities as well as potential compensatory strategies. Models and theories from behavioral psychology have been employed in CR for more than 40 years. Behavioral theories are valuable in CR because they inform assessment, treatment, and the measurement of rehabilitation efficacy [31].

Holistic Model

A model of hierarchical stages in the holistic approach through which the patient must work in rehabilitation was provided. Aforementioned approach includes: engagement, awareness, mastery, control, acceptance and identity. It emphasize on the integration of cognitive, social, emotional and functional aspects of brain injury in CR rather than addressing each domain separately for rehabilitation. Most holistic programs are concerned with increasing a client's awareness, alleviating cognitive deficits, developing compensatory skills, and providing vocational counseling.

Holistic programs tend to work apparently through the Ben-Yishay's hierarchical stages and targets on (i) increasing the patient's awareness of the problems, (ii) increasing acceptance and understanding of the problems, (iii) providing strategies to improve cognitive functions, (iv) develop compensatory skills, and (v) provide vocational counselling. All holistic programs include both individual and group sessions [32].

Later, Prigatano (1999) lists 13 principles of CR derived from a holistic approach, whose work has considerably influenced current rehabilitation practices. Evidence for the effectiveness of comprehensive holistic CR approaches and probably the most effective clinically [33].

Integration model

Researchers tried to further develop the basic ideas of Reitan and Wolfson and to integrate this approach with that represented by Bracy on the basis of Luria's model.

The theoretical background for Diamant's thesis "brain is the organ processing distance between subject and object in terms of time, space and interpersonal relationships" is the "Closed Circuit Approach" (1980, 1982, and 1987). The "Closed Circuit Approach" is organized as an individual, systematic training of specific cognitive functions and abilities in a multidisciplinary design, including neuropsychological screening, re-screening and continuous evaluation of results [34].

The primary aim of the brain is to regulate the distance between the subject and the environment to increase the adaptation repertoire of the individual [35]. In this respect speed and flexibility may be considered the basic dimensions of the distance manipulations processes [36]. These processes form the general basis of the functioning of the brain and behavior as well as of the adaptation process of the individual in the continuously changing environment. Diamant has tried, to incorporate both the psychometric and non-psychometric CR approaches in the present model [37].

Anthony comprehensive rehabilitation model (ACR)

Anthony (1980) emphasized on comprehensive rehabilitation model that has been applied to the deinstitutionalization and rehabilitation of the chronically mentally ill [38]. Later, Williams (1987) also surmised the importance of implementing applied CR techniques rather than solely depending on theoretical development alone [39].

The ACR model of Williams (1987), consists of six main components: Skill and Resource Assessment, Rehabilitation Goal Planning, Skill Training, Resource Management and Plan Execution (Figure 1) [40]. This comprehensive model is distinctive and helpful in the conceptualization of rehabilitation because it specifically defines these components of rehabilitation and attempts to explain how they interrelate [41].

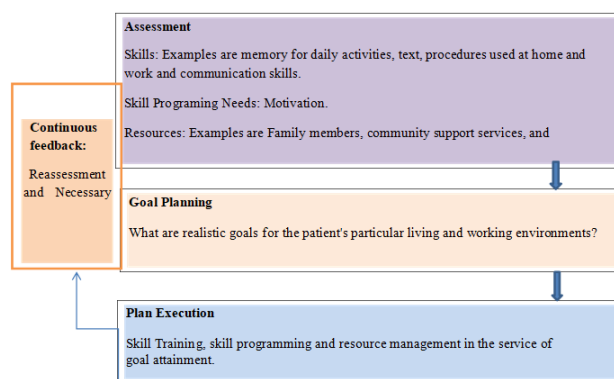


Figure 1. Major components of the comprehensive rehabilitation model.

Conclusion

This study attempts to bring an understanding based on current models and techniques in CR which, are mostly conducted among adults with acquired brain injuries succoured, on the concept of brain plasticity that enhances the functioning and independence in patients with cognitive impairments; albeit, rarely used for the neurodevelopmental disorders/acquired cognitive dysfunctions in children. Hence, a more plausible approach of the CR distinctively among children is felt, that would be more conducive and have a far better outreach relative to an adult brain.

However, from these studies, and owing to the paucity of evidence on CR effects among children in India, the Researcher here, suggests for a more rigorous scrutiny and

approach, which needs to be tailored in terms of providing a generalized child based CR models, as a foundation for customized CR process from culturally feasible, multi-centric and empirically evident based cognitive rehabilitation studies and techniques.

References

1. Baddeley AD. Memory theory and memory therapy. *Clinic Mangmnt Memory*. 1992;12:1-31.
2. Wilson B, Moffat N. Clinical management of memory problems (2nd Edn)(PLE: Memory). Psychology Press 2014;1-31.
3. Baddeley A. A theory of rehabilitation without a model of learning is a vehicle without an engine: A comment on Caramazza and Hillis. *Neuropsychol Rehabil*. 1993;3:235-244.
4. Baddeley M. Analysing herding: Insights from neuroeconomics and social psychology. In *Queens' Economics Seminar*, Cambridge University. 2007.
5. Benedict SM, HG Belanger, SD Ceperich, et al. Veterans Health Initiative on Traumatic Brain Injury. U.S. Department of Veterans Affairs. 2010.
6. Ben Yishay Y, Priganto GP. Cognitive Remediation. In *rosenthal M, Griffith. ER (eds). rehabilitation of the adult and child with traumatic brain injury* F.A. Davis, Philadelphia. 1990;393-409.
7. Bracy OL. Cognitive rehabilitation: A process approach. *Cogn Behav Ther*. 1986;4:10-17.
8. Bracy O. Computer Assisted Training Exercises. *J Cog Rehab*. 2003;4:6-15.
9. Berlucchi G. Brain plasticity and cognitive neurorehabilitation. *Neuropsychol Rehabil* 2011;21:560-578.
10. Caramazza A, Hillis AE. Where do semantic errors come from? *Cortex*. 1990;26:95-122.
11. Cicerone KD, Dahlberg C, Malec J, et al. 2005. Evidence based Cognitive rehabilitation: updated review of the literature from 1998-2002. *Arch Phys Med Rehabil*. 2005;86:1681-1692.
12. Diamant JJ. Training of cognitive functions in psychiatric patients with brain dysfunctions: an attempt at integration of behavior therapy methods. *Gedragstherapie*. 1982;15:22-39.
13. Diamant JJ. Training of cognitive functions in patients with cerebral dysfunctions. *Metamedica*. 1987;148-160.
14. Diamant JJ, Hakkaart PJ. Cognitive rehabilitation in an information-processing perspective. *Cogn Behav Ther*. 1989;17:22-28.
15. Diller L. A model for cognitive retraining in rehabilitation. *Clin Psychol*. 1976;26:13-15.
16. Diller L, Gordon WA. Rehabilitation and clinical neuropsychology. *Handb Clin Neurol*. 1981;1:702-733.
17. Diller L, Gordon WA. Interventions for cognitive deficits in brain-injured adults. *J Consult Clin Psychol*. 1981;49:822.
18. Gudeman H, Golden CJ, Craine J. The Role of Neuropsychological Evaluation in the Rehabilitation of the Brain Injured Patient: A Program in Neurotraining. *American Psycholog Ass Journal Suppl Abstract Service*. 1978.
19. Greenough WT, Black JE. Induction of brain structure by experience: Substrates. In *Developmental behavioral neuroscience: Minn Symp Child Psychol*. 2013;155.
20. Haggbloom SJ, Warnick R, Warnick JE. The 100 most eminent psychologists of the 20th century. *Rev Gen Psychol*. 2002;6:139-152.
21. Howard D. 14 Language: cognitive models and functional anatomy. *Effectv rehabilitatn cognitn defct*. 2005;155-168.
22. Katz DI, Ashley MJ, O'Shanick GJ, et al. Cognitive rehabilitation: the evidence, funding and case for advocacy in brain injury. McLean, VA: *Brn Injur Associat Americ*. 2006:1-6.
23. Luria AR. Restoration of function after brain injury. 1963.
24. Luria AR. Traumatic aphasia: Its syndromes, psychology and treatment. *Walter de Gruyter*. 2011.
25. Luriiā AR, Luriiā AR, Louriā AR. Human brain and psychological processes. *Harper and Row*. 1966.
26. Luria AR. The working brain: An introduction to neuropsychology. *Basic books*. 1976.
27. Malhotra S, Bhatia MS, Rajender G, et al. Current update on cognitive retraining in neuropsychiatric disorders. *Delhi Psychiatry J*. 2009:213-218.
28. Mundkur N. Neuroplasticity in children. *Indian J Pediatr*. 2005;72:855-857.
29. Mitchum CC, Berndt RS. The cognitive neuropsychological approach to treatment of language disorders. *Neuropsychol Rehabil*. 1995;5:1-6.
30. Nelson CA. Neural plasticity and human development: The role of early experience in sculpting memory systems. *Dev Sci*. 2000;3:115-136.
31. Pena-Casanova J. Functional organization of the brain and psychic activity: a view beyond Luria (with Luria). *KnE life Sci*. 2018;711-725.
32. Prigatano GP. A history of cognitive rehabilitation. 2005.
33. Prigatano GP. Principles of neuropsychological rehabilitation. *Oxford University Press*. 1999.
34. Reitan RM, Wolfson D. The Halstead-Reitan neuropsychological test battery for adults-theoretical, methodological, and validation bases. *Neuropsychol asesmnt neuropsychiat and nuromedcal dsorder*. 2009;1:3-24.
35. Shah UR. Cognitive rehabilitation in psychiatry. *Annals Indian Psychia*. 2017;1:68.
36. Shoulson I, Wilhelm EE, Koehler R. Cognitive rehabilitation therapy for traumatic brain injury: evaluating the evidence. *National Academies Press*. 2012.
37. Tsaousides T, Gordon WA. Cognitive rehabilitation following traumatic brain injury: assessment to treatment. *Mt Sinai J Med*. 2009;76:173-181.
38. Robertson IH. Theory-driven neuropsychological rehabilitation: the role of attention and competition in

- recovery of function after brain damage. In *Attention and Performance XVII: Cognitive Regulation of Performance*. Interact Theory App. 1999;677-696.
39. Williams JM. The role of cognitive retraining in comprehensive rehabilitation. *Rehabil cognit disabil*. 1987;43-55.
40. Wilson GT, O'leary KD. *Principles of behavior therapy*. Prentice Hall. 1980.
41. Wilson BA, Winegardner J, Van Heugten, et al. *Neuropsychological rehabilitation: The international handbook*. Psychology Press. 2017.

***Correspondence to**

Dr. Pulari C

Department of Electronics and Information Engineering
Lanzhou Jiaotong University

Lanzhou

China

E-mail: febroniemariya@gmail.com