Introduction

Cognitive retraining (CR) seeks to directly improve and/or restore cognitive functions utilizing a variety of pen and paper or computerized tests or games requiring cognitive skills such as attention, planning, problem-solving, and/or memory. It is a teaching process that targets areas of neuropsychological functioning involved in learning and basic day to day functioning. Thus, a more comprehensive definition of cognitive retraining can be, “therapeutic interventions involving activities that improve a brain injured person’s higher cerebral functioning or help the patient to better understand the nature of those difficulties while teaching him/her methods of compensation”.

Theoretical Models Of Cognitive Retraining

Bracy et al. have strongly stated that CR should be grounded in theory. Many different theoretical models have been proposed to explain the process of CR and the mechanisms for change. A few important ones include:

1. Descriptive (Procedure, Transcript) Models

   The theoretical basis for CR can be traced to the work of Luria who proposed that the concept of brain plasticity. There are anatomical, physiological and psychological basis for the plasticity. Psychologically brain plasticity is conceptualized to be mediated by the re-organization and re-establishment of functions. CR approaches use the potential of the brain to change and adapt to help restore the lost functions. 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. Further support to this comes from the works of early connectionist research demonstrated that simple networks trained on unstructured tasks can, when retrained after damage, exhibit rapid recovery on treated items and generalization to untreated items.

   In addition to Luria’s model another descriptive model of CR is the model of Diller derived from the concepts of clinical neuropsychology. Here CR starts with identifying the defect of a certain ability. Then a task is chosen that appeals to the respective ability in an adequate manner and is analyzed in terms of stimulus and reaction qualities. The ability and the task are evaluated from the point of view of the activities of daily life (ADL), achievements on other tasks that may reveal abilities associated with the trained ability and with neurological correlates. Thus a rehabilitation diagnosis is formulated which forms the base of the training process.

2. Information Processing (Analytical) Models

   are based on the following three principles:-(a) principle of functional specificity, (b) principle of functional hierarchy, and; (c) principle of training circuits (tracks). Reitan et al. gave a model with three levels of information processing. The first level implies attention, concentration and memory, the second level reflects the lateralized processes, i.e. verbal and language skills in the left hemisphere and spatial and manipulatory skills in the right hemisphere. The highest level of information processing is considered as the central one, enhancing abstraction in the form of concept formation, reasoning and/or logical
analysis.

3. **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, and 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).

4. **The Holistic Model** is a model of hierarchical stages in the holistic approach through which the patient must work in rehabilitation. These are in order: engagement, awareness, mastery, control, acceptance and identity. It is emphasized that it is futile to separate the cognitive, social, emotional and functional aspects of brain injury. Holistic programmes, are concerned with (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 counseling. All holistic programmes include both individual and group sessions.

**Approaches to CR**

1. Neuropsychological Educational Approach to CR is Learning is done in real life contexts (simulated driving exp), 6-10 clients, 2-3 sessions/week for 45 min to an hour.

2. Cognitive Adaptation Training (CAT) is based upon the idea that impairments in executive functioning lead to problems in initiating and/or inhibiting appropriate behaviors. CAT utilizes environmental supports including alarms, signs, checklists, and the reorganization of belongings to cue and sequence adaptive behavior in the home environment.


**Procedures Used for CR**

CR includes a considerable amount of repetitive practice that targets the skills of interest. These methods typically involve massed practice and drill approaches, along with other psychologically based intervention methods. Cognitive deficits must be analyzed and subdivided into their individual components. Retraining then involves extended practice and over learning on tasks similar in nature to that of the component deficit. The two key elements of any CR programme are: repetition to make the skill automatic, and appropriate reinforcement. Retraining usually begins with simpler cognitive skills like attention, short term memory and information processing and then proceeds to more complex skills like problem solving. Each identified skill is retrained using graded practice of activities using the method of saturation cueing.

A number of CR methods have been utilized, many of which use specially designed computer software, and are called computer assisted cognitive rehabilitation (CACR). The empirical evidence for CACR seems to indicate a potential for improving cognitive function. There is substantial evidence supporting the effectiveness of CACR for those suffering from traumatic brain injury, and it is strongly suggested that “micro-based rehabilitation” elicited improvements in the areas of “attention/information processing” and “memory dysfunction”, new learning and problem solving skills. Most of the CR procedures are computer based as computers allow accurate timing of stimulus presentation along with the possibility to regulate time of stimulus presentation based on individual’s performance. However, the drawback of these programmes is their rigidity with respect to patient needs. The floor and ceiling level along with the task content are relatively fixed. Further, the cost of cognitive retraining soft wares is another major limitation.

Manualized CR programmes overcome these limitations though at the cost of precision. However, have found no difference in outcome between computer assisted and manualized CR methods.

Evaluation of CR needs to be done at three levels - LEVEL 1 consists of improvement on the
task which is being used as the skill enhancing activity in the session. Task specific improvement would indicate whether the patient is learning the function which is being taken up. A biweekly review of performance would indicate whether this improvement is occurring. LEVEL 2 – The second level of improvement is whether the tasks which are not routinely used as the enhancing activity but which require the same skills/abilities show similar improvement. These include other tasks with same cognitive skills in the same situation. Improvement here signifies that the improvement is not task specific but is getting generalized. LEVEL 3- This level refers to improvements in everyday behaviour and activities. If the patient functions better in spheres/tasks involving the trained cognitive skill then this indicates that the cognitive ability has enhanced.

CR for Various Neuro-cognitive domains

The neuro-cognitive domains which are usually considered for retraining include- arousal and orientation, attention and concentration, memory, visual and spatial perceptual abilities, language and verbal skills, executive functions (reasoning, planning, organization, problem solving), life skills and social skills. Enormous data to support the efficacy of CR for enhancing these domains is available:

1. **Attention and concentration** - CR aims to improve several abilities, including focusing attention; dividing attention; maintaining attention while reducing the effects of boredom and fatigue; and resisting distraction. This area of CR has been widely researched, and has been shown to improve patients’ abilities in various tasks related to attention. Visuo-spatial inattention is also reported to improve after CR.

2. **Memory** - Empirical evidence supports the efficacy of memory retraining strategies which are largely divided into three basic categories 1) the use of spared skills in the form of mnemonic devices or alternative function systems; 2) use of direct retraining with repetitive practice and drill, and 3) use of behavioural prosthetics or external devices. These gains are reported to have a positive effect on functional skills of the patient.

3. **Problem solving and Decision Making** - Problem-solving retraining is usually done using the “SOLVE,” approach from the first letter of the name of each step: Specify; Options; Listen; Vary; and Evaluate. The “SOLVE” technique is reported to be highly efficacious with individuals at a higher level of functioning.

4. **Executive functions** - Because of the increasing evidence that executive functions affect lower level tasks, more effort has been dedicated to the systematic development and evaluation of CR programmes to ameliorate these deficits. Dual task procedures along with charts and videotapes that may be used to monitor behavior, and a variety of questions, tasks, and games have been reported to be highly effective. Metacognition training which employs strategy-oriented task practice is also an effective intervention for executive functions.

5. **Visuoperceptual skills** - Irrespective of the approach (from basic skill training to functional skills or vice versa) and methodology used, all reported studies have unanimously supported that CR is effective in improving visuo-spatial skills and the gains are reported to be maintained at follow up 4 months to 1 year post-treatment.

CR as an intervention for various Neuropsychiatric Conditions

CR was initially intended to be used with those who have suffered from a traumatic brain injury (a stroke, tumor, or a head injury. However, growing empirical evidence supports its use in various neuropsychiatric conditions:

- **Dementia** - In the recent years many studies have reported cognitive improvement, functional stabilization and fewer behavioral problems following CR in dementia patients. Reality orientation therapy and validation therapy have been the most widely used and studied techniques in dementia leading to improvement in Quality of life of patients and caregivers.

- **Traumatic Brain Injury (TBI)** - By now there is ample evidence that holistic neuropsychological rehabilitation programmes, which have cognitive
retraining as a major technique improve the psychosocial outcome of head injury patients.\textsuperscript{29,30,31}

\textbf{Multiple Sclerosis (MS) -} it is reported that patients with MS have specific deficits in working strategies and that interventions aimed at improving the capacity to develop and use these strategies may necessarily precede other cognitive rehabilitation programmes. However, despite the known cognitive dysfunctions in multiple sclerosis very limited attempts have been made to reduce these impacts through CR.\textsuperscript{18,27}

\textbf{Parkinson’s Disease -} It has been reported that a CR programme was effective in reversing the cognitive deficits associated with the early stages of Parkinson’s disease, but it is reported to be highly difficult to expect such gains from CR programmes at later stages\textsuperscript{27}.

\textbf{Epilepsy-} Owing to the high prevalence and incidence rates of epilepsy, various attempts have been done towards developing effective CR programmes for the deficits in cognitive functioning associated with various subtypes of epilepsy.\textsuperscript{32} It has been found that CR is effective in ameliorating the cognitive deficits in patients with focal seizures receiving carbamazepine (CBZ) monotherapy.\textsuperscript{33}

\textbf{Substance Abuse -} CR has very important role even in cases of chronic substance abuse,\textsuperscript{20,25} which has been found to be associated with a wide range of cognitive deficits like impairments in perceptual motor skills, visual spatial functions, learning, memory, abstraction and problem solving.

\textbf{Schizophrenia} Several recent reviews of CR have concluded that the known cognitive deficits in schizophrenia respond to retraining.\textsuperscript{34,35,36} The studies have not just focused on schizophrenia, researchers reported the effectiveness of CACR on inpatients diagnosed with psychotic disorders but not meeting the criteria for schizophrenia.\textsuperscript{37} These results indicate that psychiatric patients can productively work with computers, and that computer-assisted cognitive rehabilitation can produce short-term improvements in psychiatric inpatients’ cognitive performance. These gains of CR in schizophrenia have been reported to be sustained over a follow up period of up to one year\textsuperscript{38}.

\textbf{Affective Disorders -} There is growing evidence of impairments in affective disorders. CR has been reported to be more effective in cognitive impairments in depressive disorders as compared to gains of CR when compared to gains of CR in patients with BPAD in remission or remitted mania\textsuperscript{11}.

\textbf{ADHD -} Research studies have found evidence for treatment of ADHD through CR combined with other psychological interventions like behavioural intervention and parental counseling\textsuperscript{39}.

\textbf{Learning Disabilities -} Recent studies have reported the positive effects of CR interventions to ameliorate the known neurocognitive deficits in children with learning disability.\textsuperscript{2,40,41}

\textbf{Evidence from Neuroimaging} Few recent studies provide evidence for CR leading to changes in brain functioning through various neuroimaging techniques. Functional magnetic resonance imaging (fMRI) has been used to study task-related brain activation in patients before and after 10–15 weeks of verbal memory exercises. The patients who were observed to have a 50% performance increase in a series of practiced and unpracticed auditory and visual verbal serial position tasks also had changes in brain activation on fMRI while doing the auditory serial position task (4-word lists) over the course of training. Strong temporal and left inferior frontal activations were reported post intervention whereas prior to treatment, relatively normal temporal activation but essentially absent left inferior frontal activation were noted.\textsuperscript{42,43,44}

\textbf{Conclusion} CR may refer to cognitive remediation, which implies a curative or restorative treatment, compensatory training, or environmental approaches, which manipulate the environment to decrease cognitive demands. CR is an effective intervention for enhancing various neurocognitive domains across many neuropsychiatric disorders. All but the Pilling et al.\textsuperscript{44} study conclude that clinical benefit of 1 type or another. However, owing to the paucity of evidence for CR effects beyond proximal outcomes\textsuperscript{36,41,45} as improvement on trained tasks or on closely related but untrained neuropsychological tests, there is a need for studies examining the generalization of CR gains.

\textbf{References} 1. Velligan DI, Draper M, Stutes D, Maples N,


