Doi: 10.32481/djph.2023.08.012

Cognitive Rehabilitation Interventions for Post-Stroke Populations

Meghan Mulhern, MA, CCC-SLP

Christiana Care Health System & Good Shepherd Penn Partners

As of 2023, stroke continues to be one of leading causes of significant long-term disability in the United States.[1] Cognitive deficits are a common component of post-stroke sequala, limiting or impacting participation in functional activities of daily living. In addition to having substantial impacts on the individual diagnosed with stroke, family members, caregivers, and society also absorb the impacts of post stroke cognitive impairment in acute and chronic phases of recovery. It is estimated that approximately 60% of individuals have cognitive impairments as a result of stroke in the acute stages of recovery (within one year of their stroke) and those who experience mild severity deficits have the highest occurrence of recovery.[2,3]

Given the high incidence of stroke and resultant significant impacts of cognitive impairment, there is a substantial need for evidence-based interventions and multidisciplinary efforts to facilitate return to independence, work, and participation in functional aspects of daily living.[4] Cognitive rehabilitation addresses skills in the cognitive domains of attention, memory, and executive functioning and how they impact functionality and safety. In a course of cognitive rehabilitation, rehabilitative therapists commonly refer to more advanced activities of daily living that require increased cognitive demands as Instrumental Activities of Daily Living (IADLs). Examples of IADLs may include meal preparation, managing medications, housekeeping, managing financial responsibilities, time management for appointments, and self-care.

How Does Cognitive Rehabilitation Start?

Cognitive assessments and interventions that comprise cognitive rehabilitation are within the scope of practice of speech-language pathologists (SLP), occupational therapists, and neuropsychologists. In this review, assessment and intervention facilitated by SLPs in cognitive rehabilitation will be explained to inform members of interdisciplinary teams, patients, families, and communities of the beneficial impacts of cognitive rehabilitation for stroke.

The specific education and training of a speech-language pathologist provides expertise in evaluating and intervening on how cognitive deficits impact communication within the modalities of speaking, listening, reading, and writing, which are frequently included in the demands of IADLs. In many cases, the location of stroke or brain injury can largely assist in predicting the types of cognitive deficits to be expected, given the known function of that location in the brain. The impact of cognitive impairment on communication is described as cognitive-linguistic or cognitive-communication impairment, with further analysis of deficits provided in the areas of attention, memory, executive functioning, and language. SLP involvement in cognitive rehabilitation is noted to be separate from other types of rehabilitation interventions aimed at treating aphasia and motor speech disorders that also may result from stroke and can be addressed by a SLP.

Cognitive domains addressed in cognitive-linguistic interventions include attention, memory, and executive functioning, with each domain having further sub-divisions to more specifically describe skills. Skills in attention are recognized in a hierarchy, including focused, sustained, selective, alternating, and divided attention. Deficits in visual attention, commonly observed to

be a unilateral neglect, are also recognized under the domain of attention and functionally impact reading and writing. In the context of post-stroke cognitive impairments, deficits in memory are commonly observed in subcategories of verbal and nonverbal memory, short term memory or delayed recall, working memory, and prospective memory. Executive functioning refers to skills and abilities for reasoning, judgement, problem solving, sequencing, inhibition, self-monitoring, information processing, and attention to detail.[5,6] The combination of skills in these domains interact for completion of IADLs.

Some cognitive-communication deficits are found to be specifically related to right hemisphere damage caused by stroke or acquired brain injuries. In addition to impairments in the aforementioned areas of cognition, right hemisphere damage may demonstrate more specific impacts on macrostructure components of verbal discourse and discourse comprehension. Skills in word retrieval, syntax, grammar, and phonological processing might not be negatively impacted as commonly seen in aphasia.[5] Additional impairments specific to right hemisphere damage also include reduced insight or awareness of deficits, known as anosagnosia, and visual neglects, typically causing one to ignore stimuli in left visual field.[7]

SLPs, occupational therapists (OTs), and neuropsychologists have consistent roles in initial and ongoing assessment of cognitive functioning to inform cognitive rehabilitation programs across a variety of treatment settings, such as acute or sub-acute rehabilitation facilities or therapy provided in the home, outpatient, or community-based locations. Assessment begins with screening to determine appropriate options for more specific evaluation of cognitive domains, which can include formal and informal assessment procedures to inform clinical impression of skills in functional contexts. Assessment must also recognize culturally and linguistically relevant stimuli and input from the patient, patient's family or support person, and interprofessional team as part of comprehensive approach.[5] With all components of current skills and prior level of functioning considered, severity ratings may be provided to further describe current level of functioning or degree of impairment. Not only are descriptive terms and severity ratings essential for tracking progress, but they are also informative in planning interventions and identifying needs for support in daily activities for self-care, independent living, or return to work.

Although assessment terminology is often centralized around identifying impairments or deficits, the consensus among evidence supporting cognitive rehabilitation intends to improve overall participation in personally relevant, functional tasks. Progress is measured in generalization and carryover of skills or strategies and participation in meaningful tasks. This motive also stems from the World Health Organization International Classification of Functioning, Disability, and Health (WHO-ICF) framework, which promotes capitalizing on strengths and addressing barriers to success.[4] Cognitive rehabilitation should provide simulations of how the different domains of cognition intricately interact in activities of daily living and patient specific goals to reduce disability.

What Do Cognitive Rehabilitation Interventions Entail?

Trends in literature continue to suggest the highest evidence support for cognitive rehabilitation is demonstrated when measured in patient reported outcomes concerning participation in functional tasks versus measured performance in specific, non-IADL functions within the different cognitive domains.[8] This trend continues to reiterate the goal of participation in cognitive rehabilitation and allows for recognizing the carryover of trained strategies that

ultimately may require skills in more than one domain of cognition. In keeping with principles of neuroplasticity, interventions are also recommended to be high frequency, patient-specific, meaningful, and to promote for generalization.[5,6] The specific domains of cognition are, however, considered in development of treatment goals and activities and may be necessary to measure progress specifically as a result of interventions.

Like other concepts of rehabilitation, interventions in cognitive rehabilitation can be classified into restorative and compensatory approaches. Restorative approaches attempt to repair or restore an impaired function. Compensatory approaches teach and carryover new strategies, skills, or accommodations to compensate for deficits when original function may not be able be fully recovered.[5,6] Often, family members or a support person is not only beneficial, but essential in the success in carryover of new skills or strategies. Therefore, their participation in training within treatment sessions is highly encouraged and even required prior to discharge in some situations.

Efforts to increase the evidence base for cognitive rehabilitation are ongoing because of the heterogeneity of cognitive impairments post stroke as well as the heterogeneity of participants in supporting studies. Because of this, evidence-based practice for cognitive rehabilitation for post stroke impairments may also draw upon support for cognitive rehabilitation serving individuals with acquired or traumatic brain injuries (TBI).

Attention

Direct approaches to attention in therapeutic interventions may include addressing specific levels of attention. Focused attention is the most basic level of attention, with the ability to respond to stimuli in any form, including auditory, visual or tactile. Following focused attention is sustained attention, which describes abilities to maintain attention for a duration of time. Examples of sustained attention may include reading a book, brushing teeth, or listening to a lecture. Selective attention includes completing similar activities of sustained attention, but with an additional distractor present that would require active filtering of said distraction to remain on target. Alternating attention requires abilities to shift attention between stimuli, including pausing one task, starting another task, and returning to the first task. Lastly, divided attention entails completing two tasks or responding to and processing two types of stimuli simultaneously and accurately. This is considered the highest or most complex form of attention. Examples of divided attention may include having a conversation while cooking a meal or listening to music while responding to emails.[6]

Based on performance within the different levels of attention, rehabilitation therapists may generate relevant, functional tasks to target these skills within restorative and compensatory techniques. Some restorative approaches with computer-based training and Attention Process Training (APT) have been studied in isolation with gains measured in their specific types of trained tasks, however, have not found to be significant in improving functional carryover to other tasks and patient perceived performance in IADLs.[8,9]

However, these types of interventions provided in combination with additional compensatory strategy training demonstrated the most functional and positive outcomes of attention skills in carryover measures as well within increased white matter microstructural changes and redistribution of the cerebral attention network in neuroimaging following brain injury and stroke.[8,10–12] Specific examples of direct attention training can include cancellation tasks with

single or alternating targets and completing tasks within presence or absence of a variety of distractors. Compensatory strategy training begins with education of potential distractors and their impact on overall accuracy in tasks to promote awareness or understanding for attentional strategies. Specific strategies might include managing internal and external distractions or segmenting tasks into smaller steps or shorter durations. Distractions can be present via auditory or visual stimuli as well as within physical symptoms, emotions, or internal thoughts.[5,6] Because attention skills are required for further information processing in memory and executive functioning tasks, basic or complex attention will be assessed and addressed to further improve performance in tasks that may initially be classified with memory or executive functioning demands.

Apart from the previously described levels of attention, cognitive rehabilitation may also address unilateral visual neglects under the domain of attention. Interventions provided by SLPs will specifically target increasing awareness of unilateral neglect and attention to the neglected side within communication tasks requiring reading and writing. Some examples of intervention include providing multimodal cueing or brightly colored materials to improve response to all stimuli in targeted visual field within describing pictures, reading, providing written instructions, or completing IADL tasks.[5]

Memory

Intervention for memory skills in cognitive rehabilitation typically targets delayed recall or short term memory, working memory for short term information processing, and prospective memory, recall of a planned task or action.[5,6] Across all forms of memory in therapy targets, both restorative and compensatory approaches are again considered. Restorative approaches within evidence-based practice for cognitive rehabilitation may include trials of spaced or distributed practice or retrieval along with errorless learning, an instructional technique in which errors are minimized or avoided prior to advancing to the next step of a task.[13–16] These interventions would likely initially occur in a high-intensity format in therapy sessions directed by a speech-language pathologist, but could also be trained for family members or caregivers to replicate for carryover and memory benefit outside of therapy sessions.

There is a larger body of support for training of compensatory memory strategies across all severity ranges of impairments for memory.[8] Compensatory strategy training for memory can be further divided into internal and external strategies. Internal strategies may include use of mnemonics, visualizations or imagery, associations, rehearsal, repetition, and semantic elaborations, including using additional associations with pre-existing knowledge or identifying multiple salient features of the memory target. External compensatory memory strategies entail any use of external storage of information apart from the brain with examples including calendars, to-do lists, journals, recordings, labels, pictures, alarms, timers or use of technology for prospective reminders.[5,6] For moderate to severe memory deficits, recommendations for intervention include emphasis on errorless learning and external memory strategies. Internal memory strategies have demonstrated increased effectiveness with more mild severity memory deficits and for those with a considerable level of cognitive reserve, because of the additional executive functioning skills required for strategy carryover.[8] Participation in a course of cognitive rehabilitation with a SLP can help select which memory interventions would be suitable for patient specific goals.

Doi: 10.32481/djph.2023.08.012

Executive Functioning

Executive functioning skills are often required for successful carryover of memory and attention strategies, however, can also be also at risk for impairment in the setting of stroke. If executive functioning impairments are severe, interventions may need to target increasing awareness to cognitive impairment and training of individual functional tasks with understanding that skill acquisition may not carryover to untrained tasks.[8,17] Goals to address executive functioning skills in therapy may include improving accuracy in reasoning, attention to detail, problem solving, and sequencing with tasks mimicking demands for return to independent living or work. Maximum inclusion of scenarios, stimuli, or personally relevant information is recommended to facilitate carryover of improved accuracy and strategy use outside of therapy and in real life context.

For mild to moderate severity deficits in executive functioning, evidence supports metacognitive and compensatory strategy training.[5,8] Metacognition is the awareness of one's own thought processes, which may include understanding specific changes in cognitive functioning and anticipating their impact. Applying metacognitive strategies evokes a "top down" approach in evaluating and adapting performance, specifically with cognitive demands, in everyday activities.[18] The first stage of metacognitive strategy training requires awareness of potential cognitive deficits.[19] This can be facilitated in therapy sessions, but is ultimately most successful or meaningful with personally relevant experiences or tasks. Following developed awareness, training in therapy would teach strategies for executive functioning or other domains of cognition and facilitate planning carryover of strategies. The final step would be self-evaluating one's own performance in tasks to make improvements or adjustments to performance or task execution as needed.[5,19] Standardized or personal rating systems can allow for clear differentiation between expected or predicted accuracy and actual performance when used before, during, and following a task.[19] For example, these rating systems may evaluate for accuracy, perceived levels of difficulty, or time required to complete a task, or whatever the goal may be to address. These rating systems can also be helpful for fostering motivation when performance and progress is tracked, and in turn, encourage continued use of self-monitoring skills for a variety of untrained tasks not specifically targeted in therapy sessions.

Other metacognitive strategy approaches include learning to modify or control the environment to allow for carryover of trained strategies to support attention, memory, and additional executive functioning skills or to reduce potential distractions, ultimately improving accuracy or reducing difficulty.[5,6] Some individuals significantly benefit from use of graphic organizers, time management strategies, and any strategies to increase organization in the home, with medications, in the work place, or wherever necessary. Metacognitive strategy training has been observed to be effective in acute and chronic phases of recovery post stroke when specifically trained by rehabilitation therapists.[8,19] The overall goal of metacognitive strategies is again to reduce the negative impact of cognitive deficits on task execution or performance and increasing independence, with hopeful reduction in disability.[18]

Although less supporting evidence is available in comparison to metacognitive strategy training post stroke, dual task training has some level of support for restorative approaches to executive functioning within trained tasks.[8,20,21] However, dual task training has been more specifically studied with diagnosis of TBI. Dual task training can involve any combination of motor and cognitive tasks that are completed simultaneously.[21] The demands of dual task training also simulate similar demands of divided attention, requiring completion of two tasks, at the same

time. Dual task training is often applied in other rehabilitation therapies, such as physical therapy and occupational therapy, to address gait training with anticipated distractions present at home or in the community, using simple verbal reasoning tasks completed while walking. Examples of dual task training specifically for cognitive rehabilitation may include shopping while completing calculations, discourse or conversational tasks during cooking, listening and recalling a story while working on a simple or multi-step project. Limited carryover is appreciated for training executive functioning skills to improve further carryover of visual scanning strategies to address unilateral neglect across untrained tasks.[8,20] This interaction continues to demonstrate the complex interaction of cognitive skills that benefit from ongoing support by rehabilitative clinicians to facilitate patient specific needs.

Advancements in technology are beginning to find their way into new modalities for cognitive rehabilitation interventions. Virtual Reality (VR) is now being explored to provide simulations of activities of daily living (ADLs) by also targeting underlying cognitive skills in information processing, executive functioning, attention, memory, and language. Their ecological validity continues to be explored, however, shows promising results when used in combination with traditional compensatory strategy training provided by rehabilitative therapists for overall participation gains in ADLs and in some standardized cognitive assessments over short periods of time.[8,22]

Discourse

Cognitive rehabilitation may also include addressing how cognitive impairments negatively impact discourse skills, commonly caused by stroke in the right hemisphere of the brain. Effective communication involves cognitive skills in sustained attention, memory, and executive functioning. Skills in these domains allow for topic recognition, response generation or thought organization, recall of communication partner's response, and awareness of errors and revisions.[5,23]

Interventions are structured to target both verbal and comprehension goals and would also require some degree of metacognitive training or communication partner training. Deficits in executive functioning may contribute to increased verbosity, tangentiality, impulsivity, focusing on irrelevant details, and thought disorganization in conversation.[5,24] A combination of cognitive deficits can also limit understanding of abstract or figurative language, including information that can be interpreted in many ways requiring mental flexibility. This further can contribute to difficulty making inferences or understanding macrostructure components of conversations, such as the over overall topic or "big picture" of discussions.[25,26] Further, indirect forms communication information can become more difficult to decipher, such as emotions, jokes, irony and sarcasm.[5]

In guidance provided by a speech-language pathologists, these types of discourse difficulties can be addressed with functional, patient specific goals, that may also need to be informed by family members or a support person if awareness to these challenges is reduced. Recommended therapeutic tasks would break down these macrostructure components into smaller units and prompting description of how items may be related to draw or recognize an inference. Examples of stimuli used to target these goals could include discussing news stories, having complex or opinionated discussions, organizing information into pictures to tell a story, or creating outlines for planned speaking tasks.[5]

Doi: 10.32481/djph.2023.08.012

Conclusion

The overall goals of cognitive rehabilitation in the setting of stroke are to facilitate cognitive function for participation or independence in everyday tasks, to limit the impacts or severity of disability, and to improve quality of life. These needs may evolve over time based on progress, caregiver support, or different phases of recovery after stroke. However, chronicity of stroke recovery should not discourage individuals or families from seeking guidance from rehabilitation professionals to maximize participation in activities of daily living. Individuals and their support systems can benefit from cognitive rehabilitation throughout the stages of stroke recovery if there are functional, task-specific goals related to activities of daily living along with motivation.

Ms. Mulhern may be contacted at Meghan.mulhern@christianacare.org.

References

1. Tsao, C. W., Aday, A. W., Almarzooq, Z. I., Anderson, C. A. M., Arora, P., Avery, C. L., . . . Martin, S. S. (2023, February 21). Heart disease and stroke statistics-2023 update: A report from the American Heart Association. *Circulation*, *147*(8), e93–e621. https://doi.org/10.1161/CIR.0000000000001123 PubMed
2. El Husseini, N., Katzan, I. L., Rost, N. S., Blake, M. L., Byun, E., Pendlebury, S. T., . . . Smith, E. E. (2023, June). Cognitive impairment after ischemic and hemorrhagic stroke: A scientific statement from the American Heart Association/American Stroke Association. *Stroke*, *54*(6), e272–e291. PubMedhttps://doi.org/10.1161/STR.0000000000000430
3. Tang, E. Y., Amiesimaka, O., Harrison, S. L., Green, E., Price, C., Robinson, L., . . . Stephan, B. C. (2018, January 15). longitudinal effect of stroke on cognition: A systematic review. *Journal of the American Heart Association*, *7*(2), e006443. https://doi.org/10.1161/JAHA.117.006443 PubMed
4. World Health Organization. (2001). The international classification of functioning, disability and health (ICF). Geneva: WHO.
5. American Speech-Language-Hearing Association. (n.d). *Right hemisphere damage.* (Practice Portal). Retrieved from www.asha.org/Practice-Portal/Clinical-Topics/Right-Hemisphere-Damage/
6. American Speech-Language-Hearing Association. (n.d.). *Traumatic brain injury in adults* (Practice Portal). Retrieved from www.asha.org/Practice-Portal/Clinical-Topics/Traumatic-Brain-Injury-in-Adults/
7. Salvato, G., Sedda, A., & Bottini, G. (2014, September). In search of the disappeared half of it: 35 years of studies on representational neglect. *Neuropsychology*, *28*(5), 706–716. PubMedhttps://doi.org/10.1037/neu0000062
8. Cicerone, K. D., Goldin, Y., Ganci, K., Rosenbaum, A., Wethe, J. V., Langenbahn, D. M., . . . Harley, J. P. (2019, August). Evidence-based cognitive rehabilitation: Systematic review of the literature from 2009 through 2014. *Archives of Physical Medicine and Rehabilitation*, *100*(8), 1515–1533. https://doi.org/10.1016/j.apmr.2019.02.011 PubMed
9. Barker-Collo, S. L., Feigin, V. L., Lawes, C. M., Parag, V., Senior, H., & Rodgers, A. (2009, October). Reducing attention deficits after stroke using attention process training: A

randomized controlled trial. *Stroke*, *40*(10), 3293–3298. https://doi.org/10.1161/STROKEAHA.109.558239 PubMed

10. Kim, Y. H., Yoo, W. K., Ko, M. H., Park, C. H., Kim, S. T., & Na, D. L. (2009, June). Plasticity of the attentional network after brain injury and cognitive rehabilitation. *Neurorehabilitation and Neural Repair*, *23*(5), 468–477. https://doi.org/10.1177/1545968308328728 PubMed
11. Nordvik, J. E., Schanke, A. K., Walhovd, K., Fjell, A., Grydeland, H., & Landrø, N. I. (2012). Exploring the relationship between white matter microstructure and working memory functioning following stroke: A single case study of computerized cognitive training. *Neurocase*, *18*(2), 139–151. https://doi.org/10.1080/13554794.2011.568501 PubMed
12. Fernández, E., Bringas, M. L., Salazar, S., Rodríguez, D., García, M. E., & Torres, M. (2012, October). Clinical impact of RehaCom software for cognitive rehabilitation of patients with acquired brain injury. *MEDICC Review*, *14*(4), 32–35. https://doi.org/10.37757/MR2012V14.N4.8 PubMed
13. Ownsworth, T., Fleming, J., Tate, R., Shum, D. H., Griffin, J., Schmidt, J., . . . Chevignard, M. (2013, November 5). Comparison of error-based and errorless learning for people with severe traumatic brain injury: Study protocol for a randomized control trial. *Trials*, *14*, 369. PubMedhttps://doi.org/10.1186/1745-6215-14-369
14. Sohlberg, M. M., & Mateer, C. A. (2001). Cognitive rehabilitation: An integrative neuropsychological approach. New York, NY: Guilford.
15. Sohlberg, M. M., & Turkstra, L. S. (2011). Optimizing cognitive rehabilitation: Effective instructional methods. New York, NY: Guilford.
16. Melton, A., & Bourgeois, M. (2005). Training compensatory memory strategies via the telephone for persons with TBI. *Aphasiology*, *19*, 353–364. https://doi.org/10.1080/02687030444000804
17. Rotenberg-Shpigelman, S., Erez, A. B., Nahaloni, I., & Maeir, A. (2012). Neurofunctional treatment targeting participation among chronic stroke survivors: A pilot randomised controlled study. *Neuropsychological Rehabilitation*, *22*(4), 532–549. https://doi.org/10.1080/09602011.2012.665610 PubMed
18. Jaywant, A., Mautner, L., Waldman, R., O'Dell, M. W., Gunning, F. M., & Toglia, J. (2023, May 4). Feasibility and acceptability of a remotely delivered executive function intervention that combines computerized cognitive training and metacognitive strategy training in chronic stroke. *International Journal of Environmental Research and Public Health*, *20*(9), 5714. https://doi.org/10.3390/ijerph20095714 PubMed
19. Skidmore, E. R., Holm, M. B., Whyte, E. M., Dew, M. A., Dawson, D., & Becker, J. T. (2011, April). The feasibility of meta-cognitive strategy training in acute inpatient stroke rehabilitation: Case report. *Neuropsychological Rehabilitation*, *21*(2), 208–223. https://doi.org/10.1080/09602011.2011.552559 PubMed
20. van Kessel, M. E., Geurts, A. C., Brouwer, W. H., & Fasotti, L. (2013, July 10). visual scanning training for neglect after stroke with and without a computerized lane tracking dual

task. *Frontiers in Human Neuroscience*, *7*, 358. https://doi.org/10.3389/fnhum.2013.00358 PubMed

21. Evans, J. J., Greenfield, E., Wilson, B. A., & Bateman, A. (2009, January). Walking and talking therapy: Improving cognitive-motor dual-tasking in neurological illness. *Journal of the International Neuropsychological Society*, *15*(1), 112–120. PubMedhttps://doi.org/10.1017/S1355617708090152
22. Faria, A. L., Pinho, M. S., Bermúdez, I., & Badia, S. (2020, June 16). A comparison of two personalization and adaptive cognitive rehabilitation approaches: A randomized controlled trial with chronic stroke patients. *Journal of Neuroengineering and Rehabilitation*, *17*(1), 78. https://doi.org/10.1186/s12984-020-00691-5 PubMed
23. Berube, S. K., Goldberg, E., Sheppard, S. M., Durfee, A. Z., Ubellacker, D., Walker, A., . . . Hillis, A. E. (2022, October 25). An analysis of right hemisphere stroke discourse in the modern cookie theft picture. *American Journal of Speech-Language Pathology*, *31*(5S), 2301–2312. https://doi.org/10.1044/2022_AJSLP-21-00294 PubMed
24. Minga, J. (2016). Discourse production and right hemisphere disorder. *Neurophysiology and Neurogenic Speech and Language Disorders*, *1*, 96–105.
25. Tompkins, C. A., Scharp, V. L., Meigh, K. M., & Fassbinder, W. (2008, February 1). Coarse coding and discourse comprehension in adults with right hemisphere brain damage. *Aphasiology*, *22*(2), 204–223. PubMedhttps://doi.org/10.1080/02687030601125019
26. Tompkins, C. A., Fassbinder, W., Lehman Blake, M., Baumgaertner, A., & Jayaram, N. (2004, December). Inference generation during text comprehension by adults with right hemisphere brain damage: Activation failure versus multiple activation. *Journal of Speech, Language, and Hearing Research: JSLHR*, *47*(6), 1380–1395. PubMedhttps://doi.org/10.1044/1092-4388(2004/103)