

Critical Review:
The efficacy of cognitive rehabilitation approaches for recovery of memory impairments following stroke

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This critical review examines whether cognitive rehabilitation (i.e. retraining and compensatory strategies) improves memory impairment in stroke patients. Study designs include: randomized controlled trial (2), case study (1) and systematic review (1). As a general conclusion, there is inconclusive evidence to support or refute the overall effectiveness of cognitive rehabilitation within this population. Whether clinicians should aim to reduce impairment or to compensate for the impairment is a question that remains largely unresolved. Recommendations for clinical speech-language pathologists, as well as for future research are provided in this review.

Introduction

Stroke is defined as a sudden loss of brain function that is caused by the interruption of blood flow to the brain or the rupture of blood vessels in the brain (Brookshire, 2003). Interestingly, there are approximately 9 million stroke survivors worldwide, and it is estimated that 43.9% of these patients suffer from cognitive impairment (Lawrence, Coshall, Dundas, Stewart, Rudd, Howard, & Wolfe, 2001).

The concept of cognitive impairment involves a vast array of difficulties, including memory, attention, orientation, judgment, problem solving skills and visuospatial deficits. A survey of cognitive rehabilitation practice patterns across North America indicates that stroke is the most common diagnosis for patients receiving this type of intervention, and that memory and attention are the most often targeted processes during therapy. Furthermore, cognitive rehabilitation is typically delivered by speech-language pathologists and in the form of individual treatment sessions (Stringer, 2003).

Taking into account that memory is not a unitary concept it is conceivable that clinicians' approaches in determining which aspect(s) of memory function needs to be treated will vary and largely depend on the nature and severity of the patients' impairments. Potential goals in memory intervention may be aimed at: 1) alleviating problems of learning and retrieval or those pertaining to everyday functioning; 2) specific contents such as orientation, dates, names, faces, routines and appointments; 3) modality specific impairments such as visual versus verbal memory problems; and 4) different aspects of memory such as working memory or prospective memory (Cappa, Benke, Clarke, Rossi, Stemmer & van Heugten, 2005).

Historically, there have been two general approaches to memory rehabilitation: 1) restoration or retraining, often using drillwork; and 2) compensation with internal (e.g. mnemonics) or external (e.g. diaries, notebooks) devices or environmental manipulations (Turkstra, 2001). It is reported that speech-language pathologists are as likely to employ each of these approaches in their clinical practice (Stringer, 2003).

Research attempts in this field appear to either target retraining techniques, compensatory techniques in the form of non-electronic external memory aids (e.g. notebooks) or the use of assistive electronic technologies. For the scope of this literature review, an emphasis will be placed solely on the former two approaches as these correspond best to the practice patterns that predominate clinically, as outlined by Stringer (2003).

Objectives

The main objective of this paper is to critically evaluate existing literature regarding the efficacy of cognitive rehabilitation approaches (i.e. retraining and compensatory strategies) for recovery of memory impairments following stroke. A second objective is to propose evidence-based practice recommendations for future research and clinical practice in the memory rehabilitation domain.

Methods

Search Strategy

Computerized databases, including CINAHL, Pubmed, Medline-Ovid and Cochrane Library, were searched using the following strategy:

((memory rehabilitation) OR (cognitive rehabilitation)) AND ((rehearsal) OR (retraining)) AND ((compensatory) OR (compensation)) AND ((cerebrovascular accident) OR (stroke))

Selection Criteria

The studies included in this critical review were required to examine the impact of cognitive rehabilitation for improving memory functions in stroke patients. No limits were set on the demographics of the research participants, the time frame or the outcome measures.

Data Collection

Results of the literature search yielded the following types of articles that are congruent with the previously stated selection criteria: randomized controlled trial (2), case study (1), and systematic review (1).

Results

Compensation with Internal Strategy Training

Doornhein & De Haan (1998) used a randomized controlled trial to evaluate the efficacy of a memory training program. After being selected to participate in the study, 12 first-time stroke patients were randomly assigned to either a treatment group that trained the use of mnemonic strategies or a control group that performed drill and practice exercises (between-subject factor). Both groups were compared on target and control tasks, and on subjective judgment scales at pre- and post-training intervals (within-subject factor), making this study a mixed group design. A series of two-way ANOVAs revealed that training of mnemonic strategies facilitated face-name learning. However, memory strategy training had no significant effects on overall memory improvement or subjective memory complaints.

This study consisted of various methodological strengths that made for a well-designed clinical trial. For example, the authors assured that any observed differences between the groups could be attributed to the experimental protocol by including a) specific exclusion criteria for deficits that could interfere with the training program (e.g. apraxia, agnosia, severe aphasia); b) equally treated groups apart from the experimental treatment; and c) groups characterized by similar ages and educational backgrounds. The use of a two-way ANOVA for each outcome measure was appropriate since the study sought to investigate the effects of two independent factors (treatment condition and pre- and post-training intervals) on memory performance as the dependent variable. A careful attempt was also made to control for potential learning

or re-test effects (via the use of parallel forms of the three outcome measures) and for spontaneous recovery of memory (via the incorporation of control tasks in each experimental condition).

Conversely, the results of this study should be taken with some caution as several issues pertaining to methodology were also found. Firstly, a small sample size was included and subject selection for the study was not randomized. The fact that the subject pool consisted of patients who had complained about memory problems on their initial neuropsychological assessment, reflects a biased sample that may not be representative of the general population. Despite this flaw, the participants were randomly assigned to either experimental group thereby increasing the internal validity of the study. Furthermore, the testing procedure was not blinded as the evaluations were done by the same person who carried out the training sessions. Therefore, it is possible that researcher bias could have influenced the differences displayed in the results. Finally, the scope of this study is limited to the immediate outcome as long-term effects of the training protocol were not evaluated through follow-up procedures.

Cognitive Retraining versus Compensation

Hildebrandt, Bussmann-Mork & Schwendemann (2006) used a randomized controlled trial to determine whether group oriented memory training programs led to improved memory and attention functions in 62 patients. The participants were randomly assigned to a process-oriented treatment (POT) group, a strategy training (ST) group or a control group. The results indicated that 1) more intensive treatment programs (POT and ST) led to significant improvements in verbal memory skills; 2) an emphasis on encoding and retrieval processes was more effective than teaching compensation strategies; and that 3) trained skills generalized onto untrained tasks and attention tasks.

Although this study arrived at important conclusions regarding memory rehabilitation, the results should be interpreted with caution as various methodological flaws were found. Aside from the fact that a large enough sample size was included for discerning group differences reliably, the method by which the participants were assigned to either experimental group is questionable. For example, half of the target number of participants was randomly assigned to one of three groups, while the other half was matched on the basis of pre-defined demographic variables in order to yield statistically balanced groups. Furthermore, the control group consisted of fewer participants than did the two treatment conditions and the evaluations were not blinded. A random allocation procedure in combination

with experimenter blinding considerations would have increased the internal validity of this study.

The statistical analyses that were performed in this study are also debatable. The authors used an ANOVA to compare each group separately with the control group. Instead, an analysis that included all three groups for identifying a potential interaction effect (e.g. 3X2 mixed ANOVA) would have yielded more reliable results. Finally, no conclusions could be made about the programs' long-term effects as no follow-up procedures or ecological rating scales were performed. The authors' hypotheses were not listed and the treatment protocols that were delivered to each group were not clearly described. Thus, replication of the present study to confirm and/or elaborate upon its findings is fairly limited.

Treatment of Verbal Working Memory

Vallat, Azouvi, Hardisson, Meffert, Tessier & Pradat-Diehl (2005) implemented a multiple-baseline-across behaviour design to train processing and storage components of verbal working memory in a single patient who suffered a left hemisphere stroke. After training 8 working memory tasks, significant improvements were noted in processing and storage processes and on ecological questionnaires related to verbal communication and working memory during everyday life skills.

Although this case study falls lower on the hierarchy of research designs, it relays clinically valuable information with regards to a potentially effective rehabilitation approach for working memory deficits. Careful attempts were made by the authors to control for a number of extraneous factors that could have impeded on the quality of the results. These include two baseline assessments controlling for spontaneous recovery of memory functioning, control measures ruling out potential non-specific training effects, and parallel versions of the tests limiting re-test effects. Furthermore, the incorporation of a control group to the case study design not only allowed for "typical" achievement levels to be established for each memory tasks, but also for determining whether the patient's post-treatment scores approximated more typical response accuracies.

On the contrary the following methodological weaknesses need to be considered in evaluating the soundness of the results. Firstly, the degree to which the patient's improved performances can be confidently ascribed to the effects of the training is limited due to a potential task order effect (e.g. each of the eight tasks was trained in the same order during each session). Secondly, the study did not include any

follow-up procedures for identifying the functional effects of the training program. Despite not having obtained this data, the researchers were able to infer that transfer to everyday life skills did occur based on the qualitative reports that the patient had returned to work on a full-time basis at his previous level.

Systematic Review of Memory Rehabilitation

Cappa et al., (2005) conducted an updated systematic review for the clinical effectiveness of cognitive rehabilitation across a vast array of non-progressive neuropsychological disorders in stroke and traumatic brain injury (TBI) patients. Given the limited number and generally low quality of randomized clinical trials in the memory domain, the authors included other systematic reviews, small group studies or single case studies. As a result, the authors judged the use of memory training without the use of external aids as possibly effective, the use of learning strategies such as errorless learning as probably effective, and the use of a combined treatment approach involving non-electronic external memory aids (e.g. diaries, notebooks) and internal strategy training (e.g. mnemonics) as possibly effective. Recommendations for future research endeavours and clinical practice were provided.

One of the strengths of this review is that it appears that all relevant studies were identified using appropriate databases and additional sources (e.g. textbooks). However, it is unclear as to whether follow-up from reference lists or personal contact with experts was performed. The reviewers adopted an appropriate method for assessing the quality of the included studies and for solving any discrepancies. Data collection and analysis of evidence was determined by a specific scoring system and was circulated amongst several other individuals for solving inconsistencies.

The greatest limiting factor about the applicability of the review's results is that the population covered by most of the reviewed studies involved mixed aetiologies (stroke *and* TBI patients). It is evident that many differences between TBI and stroke patients exist, with the most obvious being the nature of the cerebral damage. The type of damage will most definitely affect the nature and severity of the memory impairment, and it is therefore difficult to make predictions about possible outcomes on the basis of the reported results. Unfortunately, the recommendations that are outlined in this review are not specific to stroke patients and do not account for the variability that exists among this population with respect to the experienced memory impairments. Therefore, this compilation of evidence for cognitive rehabilitation

lacks external validity for preferential treatment outcomes in the stroke population.

Conclusions

A critical review of the literature has demonstrated some empirical support for the use of *specific* rehabilitative techniques for recovery of *identifiable* memory problems following stroke. However, as a general conclusion, there is inconclusive evidence to support or refute the overall effectiveness and long-term benefits of frequently employed cognitive rehabilitation approaches within this population.

Moreover, whether cognitive rehabilitation should aim to reduce impairment or to compensate for the impairment is a question that remains largely unresolved. This conclusion is largely based on the absence of evidence rather than evidence of absence of an effect of memory intervention protocols (Evans, 2006). For example, of the available research that is specific to stroke patients, only one randomized controlled trial reports results that suggest the use of a simple internal compensatory strategy (Doornhein & de Haan, 1998), whereas a later trial describes the beneficial effects of a rehearsal-based strategy (Hildebrandt, 2006).

The reviewed evidence also suggests that the application of a therapy protocol that focuses on the aspect of memory that is selectively impaired (e.g. working memory) can be effective in both clinical and natural environments (Vallat et al., 2005). Additionally, there is sufficient support to conclude that more intensive treatment programs can lead to significant improvements in verbal memory skills regardless of their therapeutic focus (Hildebrandt et al., 2006).

Recommendations for Future Research

Given the lack of evidence for cognitive rehabilitation in stroke patients, it is evident that further research is needed for developing more reliable conclusions about the effectiveness and applicability of memory intervention approaches. Based on the appraised methodologies, researchers working in this area are strongly encouraged to:

1. Control for patient characteristics, especially aetiology (e.g. stroke *versus* TBI participants), in order to create more homogenous samples.
2. Make direct comparisons between “memory-impaired” stroke patients and “non-memory-impaired” non-stroke patients for discerning anticipated levels of recovery from more “typical” response accuracies.

3. Include multiple-raters in the evaluations of memory to reduce the effects of experimenter biases.
4. Include follow-up measures at various time intervals to determine the ecological validity and long-term benefits of the applied rehabilitation approach.

Recommendations for Clinical Practice

Although the aforementioned empirical limitations lead us to exercise caution in interpreting the results of the reviewed studies, positive memory outcomes did emerge as a result of specified rehabilitative techniques. Based on these reports, clinical speech-language pathologist should:

1. Aim to directly deliver five 1-hour therapy sessions per week for a 4 week period since more intensive treatment leads to more favourable outcomes within this population.
2. Incorporate into their practice, independent reports of daily life memory performances (e.g. from caregivers or spouses) to monitor real-life progress, since patients with severe memory problems may be unaware of or have skewed perceptions about the effectiveness of the applied treatment.
3. Consider the appropriateness of each training program in relation to the individual profiles of memory disturbances (Doornhein & de Haan, 1998), as programs targeting specific aspects of memory proved to be beneficial both clinically and during real-life applications.

As a general conclusion, clinical speech-language pathologists and researchers in the field need to be reminded that rehabilitation is ultimately concerned with the ability of individuals to participate in valued activities. Thus, researchers should consider the possibility that differentiating the efficacy of distinct rehabilitation approaches is not as important as providing these patients with the most valuable tool-set which may include a combined treatment approach involving both compensation and retraining strategies.

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