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Cognitive training in home environment

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Primary objective: To examine the efficacy of cognitive rehabilitation in the patient's home or vocational environment.
Research design: Pre–post-follow-up design.
Methods and procedures: Ten outpatients with acquired attention and memory problems received cognitive training three times weekly, for 3 weeks. They received individual attention training with Attention Process Training, training for generalization for everyday activities and education in compensatory strategies for self-selected cognitive problems. Treatment effects were evaluated with neuropsychological and occupational therapy instruments before and after the training and after 3 months on impairment, activity and participation levels.
Main outcomes and results: The results indicated a positive effect on some measures on impairment level, but no differences on activity or participation levels at follow-up.
Conclusions: The study indicates that home-based cognitive training improves some attentional and memory functions and facilitates learning of strategies. Future controlled studies are needed to confirm the results and analyse the efficacy of different aspects of home-based training.

Introduction

Deficits in attention and memory are common after acquired brain injuries [1–8]. Patients report problems with maintaining concentration over an extended period of time, distractibility, forgetfulness and the ability to do more than one thing at a time. Furthermore, they often experience difficulty with fatigue [9], decreased reaction time and reduced speed of information processing [10, 11]. These difficulties decrease the reintegration to family, community and work and influence leisure activities [12–19].

During recent years, extensive reviews were published on the efficacy of cognitive rehabilitation [20, 21]. Several reports have described the effectiveness of using compensatory strategies and the use of devices, particularly for patients with mild-to-moderate memory impairment [21–23]. Studies that have examined the effectiveness of compensatory strategies suggest that external aid is effective if the intervention is individually adapted and if the patient is actively involved in identifying the memory problem to be treated and motivated to use the aids [4, 20].

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One of the pitfalls of cognitive rehabilitation is that generalization of therapy efforts does not occur spontaneously. Patients with brain damage often fail to adapt new strategies learned in therapy, to home and work environments [1, 14, 24–26]. According to several researchers, treatment should be conducted in the home and community, rather than in the clinic, to facilitate generalization of training [12, 19, 27–29]. Thus, optimally therapy should be conducted in the client's well-known and natural environments [27, 30, 31] to facilitate generalization.

Attention difficulties are in many cases one of the greatest impediments to successful rehabilitation, because attention problems frequently underlie other cognitive deficits [19, 32]. Logically, it could be argued that the remediation of cognitive deficits should begin in the area of attention. Cicerone *et al.* [21] and others [33–35] found that specific attention training was more effective than non-specific during the post-acute phase. Attention is commonly integrated in the training of range of cognitive functions and there are also specific treatment programmes for training attention [17, 24, 35]. One example of attention training is the Attention Process Training (APT) [16, 36]. A series of studies has reported significant post-treatment improvement after training with APT on standard measures of attention [37, 38].

Most studies have relied on neuropsychological measures to assess improvements in attention and memory to attributable to treatment. Several studies by Bernspång and Fisher [39], Carney *et al.* [20], Ponsford and Kinsella [11] and Uomoto [19] have argued that the neuropsychological measures are not enough, because the measures only identify cognitive impairments. However, only a few studies have included naturalistic observations or behavioural ratings [21] to identify limitations in performance of an activity or loss of social role function because of the disability.

Studies about the effectiveness of cognitive rehabilitation on impairment, activity and participation levels for persons with acquire brain injury are limited. In the present study, the measurements were selected to measure changes on impairment, activity and participation levels, since a number of studies argued for an inclusion of these measures for increased ecological validity [4, 12, 20, 21, 39–41].

The present study is an explorative intervention to examine the efficacy of cognitive rehabilitation for adults with acquired brain injuries in their own home or vocational environment and to evaluate the effects not only on impairment, but also on activity and participation levels.

Method

Participants

The participants comprised a consecutive series of 10 outpatients with mild-to-moderate acquired non-progressive brain injury at a neurological rehabilitation clinic outside Stockholm. The participants lived independently in the community. They were all at least 9 months post-injury so that the spontaneous recovery is no longer thought to account for improvement and all of them have had an extended rehabilitation period at the clinic. None of the participants had any other rehabilitation treatment going on. Inclusion criteria were deficits in attention and memory based upon neuropsychological assessment. Exclusion criteria were aphasia, MMSE ≤ 23, lack of understanding Swedish, substance abuse and/or current psychiatric illness. The participants had minor or no motor dysfunction. Mean age was 47.5 years. The age distribution of patients was representative to the patient population in the clinic. One patient worked full time at a new job and two were training at their earlier job 25% of full-time and seven patients were on sick leave. For demographic data see table 1.

Procedure

All participants received individual cognitive training, 1-hour, three times weekly, in their homes or at work, for a period of 3 weeks. The programme included APT-training, generalization for training and teaching of compensatory strategies for self-selected cognitive problems. The compensatory strategy training took place at home, outdoors and at work according to the order of priorities defined by the patient. In order to minimize the effect of fatigue, the training took place in the morning. To evaluate treatment effects, neuropsychological tests, occupational therapy-instruments, as well as questionnaires, were administered before and after the 3-week periods of training and at the follow-up after 3 months.

Intervention programme

The programme was based on the principle of mixing the remedial and adaptive functional approach [42, 43]. The intervention also included identification of cognitive problems in everyday life. The treatment period started by having the participants in consultation with the occupational therapist list number of tasks that they would like to perform better. They assigned an order of priority and which problem to start with. Every training session consisted of (a) APT-training, (b) generalization for training and (c) teaching of compensatory strategies for self-selected tasks.

(a) All participants received attention training for 20 minutes from the APT-material. Examples of attention process training exercises are listening for target words sequences on attention tapes and pressing a buzzer when the target is identified. Example of exercises for selective attention are tasks requiring listening for one type of target word or sequence on attention tapes and then switching to listening for a different type of word or sequence or tasks with background distracter noise. The occupational therapist picked out a task approximately at 50% hit level and the participant continued with the task up until the 85% performance level and proceeded after that to a more complex level. The participants were given verbal and visual feedback on their performance in every session.

(b) The second part of the treatment session consisted of teaching strategy generalization tasks for everyday activities related to APT-training. Cicerone *et al.* [21] suggested that it is important to teach the patients to use the strategies independently and to apply the strategies to new situations. For example, if the participants were training sustained attention according to the APT method, they were taught to register for how long they could be concentrated, while reading the newspaper and monitor changes from day-to-day [17].

Table 1. Diagnostic and demographic data for the participants

Participants	Sex	Age	Diagnosis	Lesion localization	Years of education	Months since injury/illness	MMSE score
A	M	57	Multiple cerebral infarction, caused by an a. vertebral dissection	Bilateral occipital lobe, small widely spread infarctions throughout the brain and somewhat larger sub-cortical areas (MRI)	16	13	29
B	M	60	Intracerebral haemorrhage	Left temporal/parietal lob (CT)	20	12	29
C	F	27	Multiple cerebral infarction, due to thrombosis in a. basilaris	Left cerebellum and bilateral thalamus, parahippocampal areas and pulvinar (MRI)	12	27	27
D	F	58	Subarachnoid haemorrhage and cerebral infarction	A cerebri media, dx.-aneurysm, CI in basal ganglia dx.(CT)	9	11	28
E	M	50	Intracerebral haemorrhage	Frontal/temporal/parietal lobe dx. (CT)	9	18	25
F	F	22	Encephalitis (meningococcus)	No assessment done acutely, CT after 3 years is normal	12	40	29
G	F	51	Intracerebral haemorrhage	Changes in left parietal lobe, (dorsal), spleninum and a minor part of the left medial occipital lobe (CT)	10	9	24
H	M	37	Traumatic brain injury	Contusion haemorrhages in the right frontal lobe and left side of the brain stem. (CT) No records of GCS and coma length	12	26	29
I	M	54	Encephalitis (tuberculosis)	The surface of the left parietal/occipital lobe (CT)	15	9	30
J	F	59	Subarachnoid haemorrhage	Left cerebri anterior communicants aneurysm (CT)	10	12	25

(c) The last 20 minutes of the training session focused on discussing possible compensatory strategies related to the listed problems as mentioned above. Strategies were applied to well-known principles of attention and memory techniques, including use of external and internal compensatory strategies for use in everyday life [17, 44, 45]. Most of the participants had concentration deficits, and experienced a reduced capacity to process information. For example, they were taught to develop realistic expectations for productivity and to take a break when they began to rate themselves with higher levels of fatigue or reduced attention and to do more demanding tasks in the morning and to schedule only light activities later on and to shop on the off-hours in the smaller stores to avoid crowds.

Assessment methods

Participants were assessed on impairment, activity and participation levels. Tests on impairment level were selected to assess attention and memory functions. The Attention Process Training test [16] was used to determine the level of difficulty for the APT-training material. The test was also administered before and after training and at the follow-up to assess improvement in performance. The Digit Span Test, from the WAIS-R [46] according to the WAIS-R-NI procedure [47], was used to measure auditory attention and short-term retention capacity. The Digit Span was administered before and after training and at the follow-up.

For verbal learning and memory, the Claeson-Dahl test, CD-test [48, 49] was used. The test consists of 10 words that the patient had to learn after repeated presentation (maximally 10 times) and a free recall retention task after 30 minutes. Two scores are given, a learning-profile and retention score. The test was administered before training and at the follow-up. The Rivermead Behavioural Memory test, RBMT [50], was administered to assess everyday memory problems. The RBMT was administered before and after training and at the follow-up.

On activity level, The Assessment of Motor and Process Skills, AMPS [28, 39], was used to measure the participant's everyday skills on two instrumental ADL tasks. The AMPS was administered before training and at the follow-up. The AMPS is a performance-based, functional assessment used to simultaneously assess both the ability to perform personal or instrumental ADL tasks.

On participation level, The European Brain Injury Questionnaire, EBIQ [51], was used to assess self-reported difficulties in everyday functioning before training and at the follow-up. A visual-analogue scale was used for rating of self-perceived quality of life, QoL [52].

Statistical methods

Changes over time was analysed by using the Wilcoxon's matched pairs signed ranks tests, $p = 0.05$ was considered statistically significant [53].

Ethical considerations

The Ethical Committee at the Karolinska Hospital approved the study. The participants received written information regarding their participation in the study, and they all gave oral consent to participation.

Results

The five parts of the APT test and the Digit Span task measured changes in attention and concentration. Significant changes were found on the more complex tasks between the pre-training session and the 3 months follow-up for complex sustained attention ($Z = 2, 39$, $p < 0.05$), selective attention ($Z = 2, 08$, $p < 0.05$) and alternating attention ($Z = 2, 71$, $p < 0.01$) and a similar trend was observed for divided attention ($Z = 1, 80$, $p < 0.10$). There was also a significant increase in performance from pre- to post-training measurements in complex sustained attention ($Z = 2, 20$, $p < 0.05$), selective attention ($Z = 2, 4$, $p < 0.05$) and alternating attention ($Z = 2, 7$, $p < 0.01$) with a similar trend for divided attention ($Z = 1, 9$, $p < 0.10$). No significant changes were observed on the simpler tasks, such as Digit Span and the simple sustained attention task, where performance was close to ceiling level before the training. Mean values are presented in figure 1.

Changes in memory were measured objectively by the RBMT and Claeson-Dahl memory test and subjectively by the cluster of questions assessing cognitive problems in the EBIQ, which also includes other cognitive aspects than memory. Performance on the RBMT improved significantly at 3 months follow-up ($Z = 2, 21$, $p < 0.05$), while there was no significant improvement immediately after training ($Z = 1, 42$, ns) (figure 2).

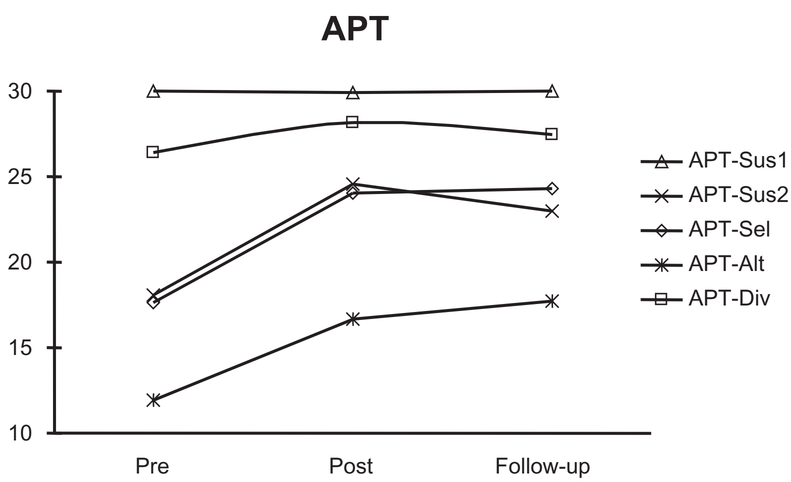

Figure 1. Mean values for attention tasks on Attention Process Training Test.

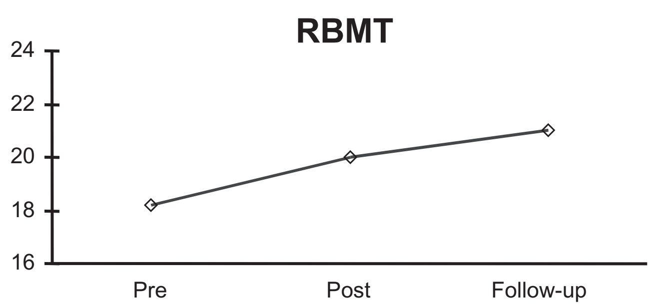

Figure 2. Mean values for memory tasks on The Rivermead Behavioural Memory Test.

Differences on the Claeson-Dahl Memory test were not significant. No significant improvement was observed on measures on activity (AMPS) and participation (QoL and EBIQ) levels.

Discussion

The results indicated a positive effect of home-based cognitive rehabilitation for some measures on impairment level, but not for measures on activity and participation level. The targeted cognitive areas were attention and memory. Improvement of attention was most pronounced on more complex tasks on attention, as in Cicerone *et al.* [21]. Improvements on memory were less distinct and the effects measured by the RBMT were most pronounced at the 3 months follow-up. These results are in line with several studies, showing the largest effect of training at follow-up [1, 21, 54].

The positive results are noteworthy since they were achieved in an home environment after participating in a rehabilitation programme with training located at the rehabilitation clinic and spontaneous recovery was ruled out as an explanation for the improvements. The memory strategy training was highly individualized and took place in the morning when the participants were optimally rested. It seems that the well-known home environment had a positive effect on the learning process.

The compensatory memory training differed considerably from the tasks in RBMT, which is assessing everyday memory problems on impairment level. However, it is difficult to separate the effects on attentions and memory, since treatment sessions contained both attention and memory training. The attention training is expected to have a crossover effect on memory training. Thus, the increase in performance on RBMT might suggest a certain degree of generalization.

It was expected that measures on activity and participation level are the best indicators of the effects of generalization [20, 29]. In contrast to measures on impairment level, the measures on activity and participation levels did not show any effects. The question is; was the training inefficient on activity and participation levels or did we apply the wrong parameters?

AMPS was selected because it was defined as a measure on activity level. Measures on activity level cover by definition a wide range of cognitive domains. Thus, there is a possibility that AMPS was not the most appropriate measurement for observing treatment effects directed towards the improvement of attention and memory, since the method is mainly focusing on motor and process skills. There is also the possibility that the wide range of cognitive domains involved in activity measures increases the variance. The minimal effect size for measurable change needs to be much larger in order to obtain statistical significance [28].

EBIQ and QoL were selected for measuring participation level. However, the use of self-rating instruments within the field of brain injury rehabilitation has been controversial due to the possibility of limited insight, related to certain lesion localization [55, 56]. It is common that brain-injured patients in the first period of time after the injury may not show a full realization of the effects of their injury [32, 40, 57–61]. Self-rating instruments assess patient's beliefs about their performance and they can have a compromised ability to recall instances of memory failure [40]. Other reachers have found that the self-rating instrument obtained relatively accurate information about everyday memory performance [4, 51]. In the present study, participants appeared to have a basic self-awareness of their performance and they had a realistic appraisal about how these deficits impact upon their every-day functioning. Changes in daily activities and in the subjective experience of difficulties and quality of life are the result of a long-term rehabilitation and slow intra-psychic change [56]. Emotional processing during a follow-up time of 3 months is very probably too short to integrate the newly acquired cognitive skills and change the self-perception. Bergquist *et al.* [12], Dirette *et al.* [62] and Prigatano [63] suggest that quality of life could increase by cognitive rehabilitation. However, the awareness of increased QoL is due to several dimensions and is probably not changed by such a short training period.

Another explanation for the negative results could be the choice of follow-up interval. Several studies have found that it is difficult to implement new habits, even without cognitive problems [17, 64, 65]. Maybe the participants needed more time to integrate the learned strategies into a wider range of behaviours, which indicted that a follow-up after 6 months could be more effective [1, 21].

On the other hand, 3 months is a rather long time for negative life events to occur and this could influence the result. In the study group, three out of 10 patients had serious negative life event during this period. Cognitive abilities are overlapping and are influenced by emotional difficulties, behavioural difficulties, social functioning and physical problems [17, 21], cancelling the possible positive effects.

Another way to measure effectiveness could be in terms of patient's desired outcomes [1, 29]. Future efforts to validate the effectiveness of cognitive rehabilitation should include evaluation methods more closely related to the strategies trained and functional outcomes, such as the use of compensatory strategies to accomplish real-life demands, performance on everyday activities in the person's home or community, changes in level of productivity [12, 20]. The results of the present study indicate that there is a great need to develop reliable and valid measures for such evaluation.

In conclusion, it seems that the well-known home environment had positive effects on the learning. Future studies for evaluation of cognitive training in home environment should preferably focus more measures on the specific domains that are treated. The results give some support for the beneficial effects of home-based training. There is a conflict between quality and time, because home training is more expensive in the short run, due to higher labour-costs. However, improved generalization skills might give better basis for adjustment in the home and work environments, possibly reducing long-term care costs and demands.

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