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ORIGINAL COMMUNICATION

Helmut Hildebrandt
Barber Bussmann-Mork
Günter Schwendemann

Group therapy for memory impaired patients: A partial remediation is possible

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PD Dr. phil. H. Hildebrandt (✉) ·
Prof. Dr. med. G. Schwendemann
Central Hospital of Bremen-Ost
Department of Neurology
Züricher Str. 40
28325 Bremen, Germany
E-Mail:
helmut.hildebrandt@uni-oldenburg.de

PD Dr. phil. H. Hildebrandt
University of Oldenburg
Clinical and Health Psychology
PO 2503
26111 Oldenburg, Germany

Dr. phil. B. Bussmann-Mork
Rehabilitation Clinic of Wilhelmshaven
Department of Neurology
Bremer-Str. 2
26382 Wilhelmshaven, Germany

Abstract *Background and purpose* To analyse the prospect of memory training for patients with organic brain damage. *Methods* Sixty-two patients with memory disorder were assigned to three different groups: a control group (n = 16) with low dose memory training, a process oriented memory training group (POT) (n = 24) and a group (ST) who was taught to compensate for memory problems with different strategies (n = 22). Most of the patients had suffered a stroke. Inclusion criteria were medium to weak memory impairment defined by the patients' performance in the California Verbal Learning Test. Patients with complete amnesia were excluded. Specific care was taken that the groups did not differ in age, time since illness, duration of rehabilitation effort, verbal and performance IQ, memory and attention performance. The two treatment groups received 20 hours memory training, the low dose memory training control group 7 sessions. *Results* The treatment groups improved in verbal and prospective memory, but only the group with POT experienced a significant improvement compared with the control group. Training effects were specific, i. e. they affected verbal memory, but were not encapsulated, i. e. generalized to the recall of prose passages and of appointments. The POT group also showed a statistically weak outperformance compared with the ST group and some attentional improvement as well. *Conclusion* Memory training is effective in patients with organic brain lesion, but only if applied frequently. Comparing the two training high intensity treatments, a POT focus seems to be superior to teaching a set of compensation strategies.

Key words rehabilitation · memory impairment · group treatment · stroke

Introduction

Memory Disorder is a neuropsychological deficit of immense social and psychological meaning. The number of memory-disordered people is increasing and will increase during the next decades, since some of the diseases that cause memory disorders peak at old age. Currently, no generally accepted treatment of memory deficits is available, which directly remediates losses of performance. Some studies have shown that external memory aids may help memory impaired people to cope with their handicap (Broek et al. 2000; Wilson et al. 1997). However, there are only a small number of direct treatment studies of memory disorders, which are scientifically well-designed (for a review see Majid et al. 2000; Thöne and Cramon 1999; Robertson and Murre 1999; Matthes-v. Cramon and Cramon 1995; Kaschel

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1994; Wilson 1987). Moreover, compared with other fields in neurorehabilitation, the few investigations partly include extremely small patient cohorts (less than 10 patients, Doornheim and De Haan 1998) rely on a small numbers of training sessions (often below 15) (Doornheim and De Haan 1998; Berg et al. 1991), which are dispersed over several weeks (Solari et al. 2004). In neurovisual rehabilitation and in motor rehabilitation, the number of training sessions often approximates to forty or even more. Furthermore, the training schedule is focused on a few weeks, i. e. motor training is highly intensive. For the rehabilitation of language impairment, it has been shown that the intensity of treatment matters for outcome efficacy (Pulvermüller et al. 2001).

There is still another aspect, which may have negatively biased previous research on memory rehabilitation. Wilson (1987, 1995) focused in her seminal contribution almost exclusively on severe amnesic patients. However, it may be misleading to generalize the results from these patient groups for all patients with memory disorders. Studies on the plasticity of the motor system in stroke patients, for example, have all been conducted with subjects suffering from a unilateral stroke lesion and included patients who are still able to move their arms or legs to a considerable degree (Kobb et al. 1999; Miltner et al. 1999). Prospects for treating patients with a total function loss, for example in hemiplegia, are still negative (Götte and Vaterrodt 1999; Kamper et al. 2002). Animal studies have shown that symmetrical bilateral lesions show minimal recovery if any at all (Kolb 1995). Therefore, the common view of a negative prospect in functional memory rehabilitation may result from a specific subgroup, in which reorganization is very difficult to achieve, and may have been influenced negatively by studies with too few training sessions.

The fact that functional memory rehabilitation may work for some patients cannot only be deduced from such indirect arguments: there are some recent reports that document partial long-term recovery from amnesia. Henke et al. (1999) investigated the memory performance of a patient with carbon monoxide poisoning and found an improvement of memory functions in most, but not all aspects, in the course of a year. Levine et al. (2002) demonstrated for six patients with traumatic brain injury on a neurobiological level reorganization of memory functions. For elderly people it has been shown that memory training may have a significant effect lasting up to two years (Ball et al. 2002). A combination of memory training and occupational activities seems to reduce intellectual decline of patients with early stages of the Alzheimer disease (Ishizaki et al. 2002). Therefore, it seems to be necessary to re-examine the prospect of functional oriented memory training for patients with organic brain damage. Taking into account the recent developments in neurological rehabilitation, it can be argued that an ideal patient group to investigate should have medium memory impairments due to unilateral lesions, the function to be treated should be used often, and the treatment should be intensive. These criteria were exactly the starting point of our trial on memory rehabilitation, which was conducted in an in-patient rehabiliation unit setting.

Patients and methods

Patients

The study was conducted at a neurological rehabilitation unit, approved by the local ethical commission. All study patients gave their informed consent. The age of the eligible patients was between 30 and 81 years. Inclusion criteria were: (1) an organic memory disorder of acute and recent onset, (2) a memory performance of at least one item in short term free recall of the California Verbal Learning Test (CVLT, Ilmberger 1988) and of maximal 9 items in the fifth learning trial or of 8 words in short term free recall. Patients with Broca or Wernicke aphasia or an additional drug treatment for the memory disorder (i. e. treatment with donepezil) were excluded.

In the beginning, the patients were randomly assigned to one of the treatment groups or to the control group. After including half of the target number of patients, we assigned them to groups according to two pre-defined variables: age and memory performance at admittance. This was done to obtain three well-balanced groups for stastical evaluation of intervention effects (see Table 1). The median score for the fifth learning trial of the CVLT was 8 for both treatment groups and 7.5 for the control group. The median score for short-term free recall was 5 words in all three groups.

In the beginning, each treatment group consisted of 27 patients and the control group of 16 patients. Because of treatment with donezepil, we had to exclude four patients, a further two because they not only suffered a stroke but additionally suffered from multiple sclerosis and two patients because they had an additional traumatic brain injury some years before the event which led to the actual treatment.

No patient dropped out of the treatment program because of a lack of compliance.

Evaluation of treatment effects

We measured the patients' intelligence and attention for any unspecific influence on training success. The abridged version of the WAIS-R was used for the investigation of intelligence, including block design, picture completion, similarities, and information (Dahl 1986). Attention was investigated by the digit/symbol test of the "Nürnburger Altersinventar" (Oswald and Fleischmann 1986). By means of the sixth test of the "Leistungsprüfsystem" (Horn 1983), we measured phonological word fluency. Categorical word fluency was measured by presenting the subjects with three concepts, each of them for one minute. The memory investigation comprised the digit span forwards and backwards for short term memory and working memory (Wechsler 1987) two different versions of the first four tests of the Rivermead Behavioural Memory Test (Wilson et al. 1992) for the prospective memory and the memory for names, the two versions of the map test of the "Lern- und Gedächtnistest" (Bäumler 1974) for visual spatial memory,, two German versions of the CVLT for verbal memory, and two self-constructed stories for logical memory. Both stories encompassed 56 text elements, which could be maximally reproduced. Reproduction performance was standardized for a group of 20 healthy controls and z-scores were used for the evaluation of patients' performance. In the case of the CVLT and text reproduction only short delay retrieval was assessed.

Table 1 Patient groups at baseline testing

	Controls	POT	ST
N	16	24	22
Sex (m/f)	12/4	12/12	15/7
Etiology	Stroke: 13 TBI: 1 SAB: 1 Others: 1	Stroke: 17 TBI: 2 SAB: 3 Others: 2	Stroke: 11 TBI: 4 SAB: 2 Others: 5
Ages (in years)	62.44 (11.85)	63.21 (12.09)	56.45 (11.23)
Time since illness (months)	2.34 (3.37)	4.60 (10.74)	9.74 (30.28)
Duration of Rehabilitation (days)	26.94 (8.84)	25.04 (8.41)	25.95 (8.84)
Verbal IQ	99.63 (7.7)	99.8 (10.3)	95.7 (11.0)
Performance IQ	103.9 (10.6)	105.4 (9.2)	103.0 (12.3)
Digit-Symbol-Test	24.4 (9.1)	28.8 (11.6)	27.4 (12.9)
LGT Map learning	11.33 (7.41)	11.55 (4.66)	10.57 (4.61)

Figures in parenthesis = Standard-Deviation from the mean. Figures before parenthesis = mean
POT process oriented training; *ST* Strategy training; *m* male; *f* female; *TBI* traumatic brain injury; *SAB* subarachnoidal bleeding; *IQ* Intelligence Quotient; *LGT* Lern- und Gedächtnistest

We used the first and second standard deviation below the CVLT scores of a healthy control group (Hildebrandt et al. 2001) to classify patients into unimpaired, impaired and severely impaired subgroups. This was for trial 1 : 5 vs. 3 words, for trial 5 : 10 vs. 8 words, for short-term free recall 7 vs. 4 words and for short-term cued recall 6 vs. 6 words.

Each patient was tested before and after the training. Alternative versions of tests were used to avoid test learning effects. The investigation lasted a maximum of two hours distributed over two meetings.

Treatment

Participants from both treatment groups received about 20 hours of group training (length per session: 1 hour, 5 sessions per week, i. e. a four weeks training period) before being tested again. For the control group, we waited until the same number of days had passed. Training groups encompassed not more than 6 patients at the same time.

Twenty-four patients received a process oriented treatment (POT) for memory impairment. Main goals of this treatment were: (1) frequent recall of learned information (mass practice); (2) learning to cope with interference between acquisition and recall; (3) reliance on two very simple principles in optimizing memory performance, i. e. constructing a common semantic framework for the acquisition and recall of single items and learning to use spaced retrieval to consolidate information for later recall. To achieve these goals, the treatment involved learning and reproduction of at least two memory lists. In addition, participants were also trained in word fluency, to find super-ordinate concepts, subordinate examples and semantic structures. Each session started with the presentation of an eight-words-long list that had to be learned. The list consisted of two major topics, but the words were written down in mixed sequence. After acquisition participants had to retrieve the list. At retrieval, special attention was given to the question whether participants detected the semantic structure of the word list, whether they found generic terms for both of the four sets of words, and whether they used the semantic structure for reproduction. An acceptance of this strategy of learning was endorsed by appropriate cues, explaining the role of deep encoding and of the accordance between acquisition and retrieval for memory performance. After the learning of the first list, a semantic organization task or a word fluency task was introduced. Then the first list was to be remembered again (in general, some single participants were asked for a retrieval). As a next step, again, a semantic organization task or a word fluency task had to be solved. Afterwards, the participants reverted to the first list, if the last retrieval had been insufficient (in general below six words). Otherwise, a second list, structured in the same way as the first list, was introduced. Semantic similarity between lists was used to make learning more difficult, if group members performed comparatively well, or avoided if they performed poorly. Participants also had to learn and reproduce the second list.

During the rest of the session, we switched lists to increase interference and to require the participants to generate semantic structures and retrieval cues for each list. Moreover, they had to remember as much as they could until the next meeting (generally the next day), which began with a retrieval of these lists. To offer some help and to increase the frequency of retrieval effort between sessions, we introduced the spaced retrieval strategy and gave the advice actively to rehearse the list when leaving the room and waiting for the elevator; then again one hour later and again after dinner. In addition, the participants were asked to find the rehearsal frequency that suited them the best, depending on the lists and their individual performance.

The second treatment group (n = 22) received a strategy training (ST) adapted to different memory problems. Main goals of this treatment was: (1) to sensitize patients for their memory impairment; (2) to increase their feeling of control of the memory impairment by teaching them strategies, which have been shown to increase memory performance; (3) to increase their performance by specific strategies adadpted to different situations, where memory is needed. The main focus was therefore more educational (teaching strategies), and the process of acquisition and retrieval was not run through very often during one session. To achieve these goals, the first week was spent on training of strategies to learn the names of faces, the second and the third week to remember short text passages, and the fourth to remember news presented on a tape. In some interspersed sessions, biographical data had to be retrieved and structured as well. Moreover, during each meeting participants discussed which strategy seemed to be the most natural to the topic and if there might be other, more effective strategies. Specific care was taken that the participants developed a realistic view of their memory performance. This was done by presenting the session's information and comparing whether estimated performance matched real performance. The following strategies were trained: building associations between specific features of a face and the name, structuring a text and its retrieval by a sequence of "w"-questions, structuring a text through the PQRST-method (Wilson 1987), using semantic structure to encode verbal information, using external help to remember appointments. Similar to the POT group, ST-group participants received "homework": they had to practice strategies during the time between sessions and every new meeting started with a round-table discussion to determine whether they had used the strategies, how useful they were and how one could increase their positive effects on memory performance.

The control group (n = 16) received a training similar to the POT group, but only for seven one hour sessions (~ two times a week). In addition, the task to rehearse information between the sessions with the help of the spaced retrieval technique was omitted.

Results

Comparison of groups before treatment (see Table 1 and Table 2)

Before a statistical evaluation of the training effect, we analysed the homogeneity of the groups by a univariate analysis of variance. There were no statistical differences between groups in age, duration of illness, and time spent on rehabilitative treatment. Moreover, the groups did not differ in attention and in verbal and performance IQ.

We then analysed the memory performance of the three groups before the training. Again, in neither of the conducted tests were there any statistical differences. Our inclusion procedure, therefore, led to three very similar groups in age, time since lesion, memory performance, intelligence and attention.

Table 3 summarizes the percentages of each impairment level for the three treatment groups according to the CVLT parameters and pre and post training.

Effect of time and treatment (see Table 2)

We analysed the effect of time with a t-test for dependent measurement, except for the RBMT data where we used a non-parametrical Wilcoxon test. Only results below $p = 0.01$ were accepted because of multiple testing.

Control group

The control group did not improve in any of the functions tested (attention and memory), although most of the raw test scores increased.

POT group

This group showed a significant increase in the learning trials of the CVLT, and the sum of learned items. It also improved in the two recall conditions of the CVLT (see Fig. 1) and in text reproduction. A non-parametric test of the Rivermead Behavioural Memory Test items showed a higher performance in appointment and last

Table 2 Training effects

	Pre			Post		
	Controls mean (sd)	POT mean (sd)	ST mean (sd)	Controls mean (sd)	POT mean (sd)	ST mean (sd)
CVLT scores						
Trial 1	3.94 (1.53)	3.88 (1.42)	3.86 (1.46)	3.94 (1.69)	5.25 (2.05)	4.91 (1.31)
Trial 2	5.44 (1.59)	5.92 (1.72)	5.68 (1.55)	5.94 (1.95)	7.63 (2.45)	7.50 (1.97)
Trial 3	6.31 (1.40)	6.79 (1.47)	6.77 (1.80)	7.13 (1.71)	9.00 (2.73)	9.00 (2.54)
Trial 4[a, c]	7.13 (1.82)	6.79 (1.79)	6.91 (2.62)	8.13 (2.13)	9.63 (2.68)	10.07 (2.54)
Trial 5	7.44 (2.03)	8.38 (2.10)	8.00 (2.39)	9.13 (2.06)	10.17 (2.18)	10.32 (2.17)
Interference list	3.38 (1.36)	3.46 (1.32)	3.86 (1.36)	3.25 (1.18)	4.13 (1.53)	3.75 (1.27)
Short term free recall[b]	4.88 (1.82)	4.58 (1.61)	5.14 (1.93)	5.75 (1.57)	7.73 (2.63)	7.45 (2.94)
Short term cued recall[a]	6.14 (2.11)	5.70 (2.51)	7.18 (2.42)	7.00 (2.34)	8.42 (2.83)	8.36 (3.11)
Recognition-Hits	13.57 (1.45)	13.59 (2.36)	13.71 (1.95)	14.00 (2.51)	14.68 (2.06)	14.68 (1.21)
Recognition-False Positives	3.00 (3.57)	3.73 (4.68)	1.90 (2.14)	3.00 (2.15)	2.82 (3.47)	2.27 (2.05)
RBMT						
1. First name	1.00 (0.82)	1.17 (0.92)	1.05 (0.84)	1.20 (0.68)	1.42 (0.78)	1.41 (0.80)
2. Last name	1.44 (0.81)	1.00 (0.93)	1.09 (0.97)	1.87 (0.52)	1.58 (0.65)	1.23 (0.92)
3. Object	3.63 (0.50)	3.54 (0.88)	3.64 (0.49)	3.53 (0.64)	3.67 (0.48)	3.41 (0.59)
4. Appointment	1.13 (0.62)	1.33 (0.64)	1.14 (0.83)	1.67 (0.49)	1.67 (0.56)	1.86 (0.35)
Text reproduction[b, c, e]	–2.22 (1.02)	–2.71 (1.06)	–2.71 (1.14)	–2.23 (1.04)	–1.97 (1.11)	–2.03 (1.38)
Map learning	11.3 (7.4)	11.6 (4.6)	10.6 (4.6)	9.1 (2.7)	12.1 (5.2)	12.3 (5.9)
Categorical word fluency[b, d]	21.88 (5.67)	17.96 (5.82)	19.23 (4.86)	22.33 (4.72)	24.13 (7.44)	25.73 (6.26)
Digit/symbol test	24.4 (9.1)	28.6 (11.6)	27.4 (12.9)	25.5 (10.0)	33.1 (12.3)	32.3 (15.4)

POT process oriented training; *ST* Strategy training; *CVLT* California Verbal Learning Test; *RBMT* Rivermead Behavioural Memory Test. All statistical calculations were done as analysis of variance for repeated measurements

[a] $p < 0.05$; [b] $p < 0.01$ comparing POT with the control group; [c] $p < 0.05$; [d] $p < 0.01$ comparing ST with the control group; [e] z-scores

Table 3 Percentage of patients according to treatment group and impairment pre and post training

	Pre			Post		
	unimpaired	weakly impaired	severely impaired	unimpaired	weakly impaired	severely impaired
POT						
Trial 1	12.50	50.00	37.50	41.67	33.33	25.00
Trial 5	25.00	16.67	58.33	29.17	54.17	16.67
Free recall	0.00	54.17	45.83	50.00	33.33	16.67
Cued recall	16.67	20.83	62.50	54.17	20.83	25.00
ST						
Trial 1	13.64	50.00	36.36	31.82	50.00	18.18
Trial 5	9.09	36.36	54.55	40.91	36.36	22.73
Free recall	9.09	54.55	36.36	50.00	31.82	18.18
Cued recall	22.73	27.27	50.00	54.55	13.64	31.82
Controls						
Trial 1	6.25	62.50	31.25	18.75	43.75	37.50
Trial 5	12.50	12.50	75.00	25.00	37.50	37.50
Free recall	12.50	62.50	25.00	18.75	62.50	18.75
Cued recall	31.25	12.50	56.25	25.00	31.25	43.75

POT process oriented training; *ST* Strategy training. Classification according to above one standard deviation (= unimpaired), below one and above two standard deviations (= impaired) and below two standard deviations (severely impaired)

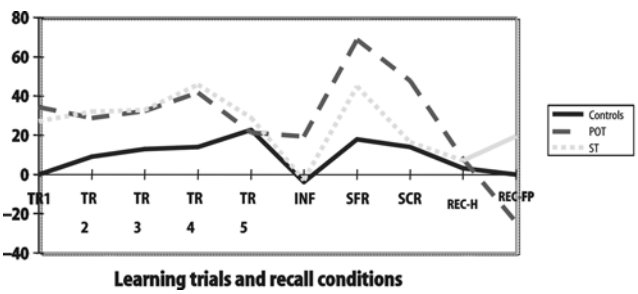

Fig. 1 Pre-post differences for CVLT (percentages). Patients with POT showed a specific increase of recall after interference, whereas both intensive training groups documented similar increase in learning the CVLT items (*TR* Learning trials, *INF* Interference list, *SFR* short term free recall, *SCR* short term cued recall, *REC-H* Recognition hits, *REC-FP* Recognition false positives, *POT* functionally oriented training, *ST* strategy training)

name learning. POT achieved a significantly increase in categorical and phonological word fluency. This group also performed better in attention testing after training.

ST group

The ST group improved in list learning (CVLT) and in text reproduction. There was also an increase in free recall (CVLT), but not in semantically cued recall (see Fig. 1). Recall of appointment, but not of name learning improved significantly (RBMT's subtests). As in POT, the application of both fluency tasks resulted in better performance than that demonstrated before training. There was no improvement in attention testing.

Training effects, therefore, concerned mainly verbal memory and spared visual spatial memory. Attention performance increased only for the POT group.

Analysis of differential treatment effects

To analyse differential training results, we compared both treatment groups separately with the control group. We used an ANOVA for repeated measurement with results before and after training as within subject variable and group assignment as between subjects variable, and replicated the statistical significance of these results by subtracting enrolment scores from after training scores to calculate a non-parametric Mann Whitney U-test. These difference scores were also used to analyse the efficacy of both treatments.

In comparison with the control group performance in categorical word fluency improved for both treatments groups with a level of significance of $p < 0.01$. Only the POT group showed a similar significant increase in free recall and text reproduction. Both treatment groups performed significantly superior to the control group in some of the memory tests with lowering the level of significance to $p = 0.05$ (see Table 2). POT and ST led to a significant interaction between tests results and groups in at least one of the learning trials of the CVLT. Both groups showed a significant higher improvement than the control group in the retrieval of orally presented texts, and both groups produced significantly more items in the categorical word fluency task. Whereas the ST group did not improve in free recall, the POT group was able to recall more items in free and semantically cued recall than the control group after the training. A comparison of the number of learned items of the last learning trial of the CVLT and the performance in free recall was taken to evaluate the rate of forgetting. We found that the POT group showed a significantly decreased forgetting rate. A direct comparison of both intensive treatments revealed two trends toward significance: The POT group showed a higher increase in semantically cued retrieval ($z = -1.785$, $p = 0.074$) and a decrease of the forgetting rate ($z = -1.870$, $p = 0.061$) in the CVLT after the training.

Fig. 2 summarizes the treatment effects for the group of severely impaired patients. Treatment with POT yielded an improvement of about 30 % of the severely impaired patients in free and cued recall (changing either to impaired or unimpaired). The analogous figures for the ST group are 18 % and about 9 % for the control group.

Discussion

The result of this study demonstrates the benefits of a high frequency neuropsychological treatment for patients with weak to moderate memory impairment after organic brain injury. Both groups with an intensive program schedule showed significant increase in verbal memory performance, whereas patients who had a training schedule with less than ten treatment sessions (our control group) did not improve in their memory performance although they were in-patients in a rehabilitation unit specialized for neurological rehabilitation. All these patients received physiotherapy, ergo therapy (occupational therapy), and in some cases also speech therapy. Occupational therapy and the small number of neuropsychological group sessions may be counted as memory training. In our view, this is a strong argument that memory performance has to be treated

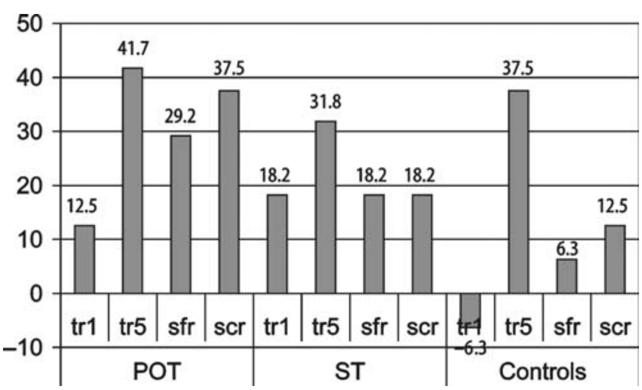

Fig. 2 Reduction of severely impaired patients in percentage for the three groups (*TR* Learning trials, *SFR* short term free recall, *SCR* short term cued recall, *POT* functionally oriented training, *ST* strategy training)

specifically and intensively to be improved by neurological rehabilitation. This statement can be partly endorsed by a direct comparison between the two high frequency treament groups. In the POT group, the major focus was on acquisition and recall during the training sessions and also with the help of spaced retrieval between the sessions. Time spent on teaching strategies was low in general. In the ST group, this relation was just the opposite: much time was spent to teach strategies and few on encoding and retrieval of information. All in all, the POT group showed considerably more significant improvements in the intra-group pre/post comparisions. Only this training – compared with the control group – led to an improvement in free recall and in text reproduction at a level of significance, which was defined a priori because of multiple testing. Furhermore, there was weak statitistical evidence that this group profited more than the ST group in semantically cued recall and by a decrease of the forgetting rate. We would like to add that the compliance of the patients for both training conception was almost identical, and, from an economical view, that the preparation time for the POT is much shorter than that for strategy training.

What are then the specific aspects, which may have led to a significant improvement in the POT group? It should be clear that every memory training session is a complex interaction between the participants, the used medium and the therapist. Because we did not include different variants of the POT, no definite answer to the question can be given, which specific aspects might be especially important. But on a general level, in addition to (1) a high frequent encoding and recalling of different information, the main focus of the POT was (2) to endorse semantic encoding, to rely on semantic cues for retrieval attempts and to make participants aware of hidden semantic structures, (3) to cope with interference between lists and verbal tasks, and between different lists, (4) to use spaced retrieval for rehearsal and to find a frequency of rehearsal adapted to the individual severity of memory impairment. Furthermore, (5) if patients did rely on other memory strategies which helped them in the short run but were misleading for a better adaptation in the long run (for example, relying on the phonological loop and developing whole stories for few items), we asked them to change the strategy. In our view, option (2) and (4) can be ruled out as an explanation for the training effect. As Fig. 1 shows, both treatment groups benefited very similarly during the learning trials. If semantic structuring is of major importance for the training effects, then one would expect a specific benefit during the learning trials and in free recall, because in these situations no external clues about the semantic structure of the list are provided. Relying on the internal representation of semantic structure should help to recover more information from memory. But the POT group improved not only in free but also in semantically cued recall and only for cued recall was there also a trend towards significance in comparison with the ST. This seems to indicate that the encoding and storing capacity itself had improved in the POT group, because the same semantic cueing helped the patients to recover more items after the treatment. On the other hand, the possibility cannot be ruled out that improvement of memory in the POT group reflects a shift in the strategy and not in memory performance as such, because this has not been tested experimentally.

Spaced retrieval on the other hand, is a powerful technique to consolidate information. But in the case of word list learning as in the CVLT, spaced retrieval is not helpful because continuous encoding triggered by aural word representation is necessary. In other words, there is not enough time for spaced retrieval to work during CVLT learning. Coping with interference (3) may be interpreted as endorsing cognitive mediation of consolidation and recall. In this case, the suppression of an inferior encoding strategy (5) is one instant of coping with interference. Only an experimental variation of different aspects of the POT will make it possible to decide whether mass practice as such or cognitive coping with interference was responsible for the training effect. It is our intuition that both are essential for a remediation of memory disorders.

One of the major arguments against training programs in neuropsychological rehabilitation, which rely rather on cognitive processes than on behavioural handicaps, is that their success may be hyper-specific and may not generalize to other situations except such as are similar to the training itself. However, this was only partly true for this investigation: visual spatial memory was not targeted and did not improve. But on the other hand, the POT treatment yielded an additional improvement in attention performance. Because the focus of this group was on interference control and partly on timed tasks, participation may have been more demanding. Thus, the increase in attention performance could be interpreted as a side-effect of the specific training design. Contrary to other approaches (Sohlberg and Mateer 1989; Gauggel and Niemann 1996) this study therefore does not argue that improvement in attention generalizes to memory performance, but that a demanding memory training session naturally taxes attention performance and may therefore also induce training effects in this domain. Furthermore, the POT generalized to other aspects of memory than list learning. The participants of the POT group were never trained in text reproduction and not in remembering appointments or names, yet they were able to solve such tasks significantly better after treatment than before. Some kind of generalization therefore occurred and helped this patient group to cope with situations that are important in everyday life (i. e. remembering short stories and appointments).

As far as we know, this is the third time (Doornheim and De Haan 1998; Berg et al. 1991) that an effect of memory training has been demonstrated for patients with organic brain damage in comparison with a control group. We share the view that in densely amnesic patients one should concentrate on specific goals or on external memory aids and the principles of teaching the patients how to use them. But as our data show, if a memory impairment is subtotal, a specific treatment seems to be possible – a situation quite similar to motor rehabilitation, where a subtotal paresis is a supposition for rehabilitative accounts to work and massed practice or forced use are effective interventions. A natural consequence would be that in subtotal memory impairment most time should be spent with training a few and specific memory subprocesses and less time on teaching mnemonic strategies. Because this would have considerable implications for memory treatment after organic brain disease, a replication of our results is warranted.

In closing, some weaknesses of our study should be mentioned: (1) we were not able to include a follow-up investigation, because the patients came from different towns and would have had to travel a considerable time to visit the rehabilitation unit again. (2) The investigations were not blinded. Because all patients got memory training (no real placebo group) this might be of minor importance, but future investigation should realize single blinding of the investigator. (3) Because of the assessment routines at the rehabilitation unit, where this study was run, we were not able to include long-delay free recall. (4) Additional, information from nurses and the patients about their view of the effect of the training would have complemented the picture. Future research should try to avoid of these flaws.

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