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Originalartikel

Is the Neuropsychological Treatment of Memory Specific or Unspecific?

Comparing Treatment Effects on Memory and Attention

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Abstract. *Primary objective and research design:* In order to analyze whether neuropsychological memory therapy acts specifically on the memory domain or in a more generalized fashion on further cognitive domains, 27 patients with organic memory deficits due to different etiologies (cerebrovascular, traumatic, infectious, etc.) were randomly assigned to two different memory treatment programs and investigated for changes in memory and attention. *Methods and procedures:* Patients treated by a specific computer-based training of story recall (Training of Verbal Memory, TVM) were compared to a group in which compensational strategies for everyday memory problems were trained (Memory Therapy in Groups, MTG). Both therapies were conducted over 12 to 15 sessions, 4–5 times per week, in addition to standard program of neurorehabilitation. Training effects were assessed for verbal and figural memory (Verbal Learning Test, Nonverbal Learning Test) and for attention (Alertness and Divided Attention in Test Battery of Attentional Performance). *Results and conclusions:* Both treatment groups resulted in improvement in tests of memory but not attention. This finding provides good evidence for the assumption of specificity of effects in neuropsychological treatment of memory.

Keywords: memory, attention, neuropsychological treatment, cerebrovascular disorder

Wirkt die neuropsychologische Behandlung des Gedächtnisses spezifisch oder unspezifisch? – Ein Vergleich von Wirkungen auf das Gedächtnis und die Aufmerksamkeit

Zusammenfassung. *Ziele und Design:* Es sollte die Frage beantwortet werden, ob neuropsychologische Gedächtnistherapien nur spezifisch auf Gedächtnisfunktionen oder unspezifisch fördernd auch auf andere kognitive Funktionen wirken. Zu diesem Zwecke wurden 27 Patienten mit organisch bedingten Gedächtnisstörungen (zerebrovaskulär, traumatisch, infektiös) nach Zufall auf zwei verschiedene Therapieprogram für Gedächtnisstörungen verteilt und ihre Veränderungen in den Bereichen Gedächtnis und Aufmerksamkeit untersucht. *Therapieprogramme und Funktionstests:* Die Patienten nahmen entweder an einem PC-basierten Training der Fähigkeit, Geschichten wieder zu erinnern (Verbales Gedächtnis, REHACOM) oder an einem Gruppentraining, in dem Kompensationsstrategien für alltägliche Gedächtnisprobleme erarbeitet wurden (Gedächtnistherapie in der Gruppe) teil. Beide Therapien wurden 12 bis 15 Sitzungen lang mit einer Frequenz von 4 bis 5-mal pro Woche zusätzlich zum neurorehabilitativen Standardprogramm angeboten. Die Therapieeffekte wurden für die Bereiche verbales und figurales Gedächtnis mit dem Verbalen Lern-Test (VLT) und dem Nonverbalen Lern-Test (NVLT) sowie für die Bereiche Alertness und geteilte Aufmerksamkeit mit den entsprechenden Tests der Testbatterie für Aufmerksamkeitsprüfungen (TAP) erhoben. *Ergebnisse und Schlussfolgerungen:* Beide Gedächtnistrainings verbesserten die Gedächtnisfunktionen, aber nicht die Aufmerksamkeit. Daher lassen sich die Ergebnisse als klaren Hinweis für die Spezifität der Effekte neuropsychologischer Gedächtnistherapien interpretieren.

Schlüsselwörter: Gedächtnis, Aufmerksamkeit, neuropsychologische Therapie, zerebrovaskuläre Störungen

Introduction

Memory deficits, which mainly affect the domain of declarative (episodic, semantic) memory, are very common consequences of acute brain disorders (e.g., stroke, traumatic brain injury); the prevalence estimates reach 60% (Müller et al., 2000). Patients suffering from memory deficits are often severely handicapped in their daily activities and lose parts of their autonomy (Wilson, 1992). Accordingly, there is reason enough to focus clinically and scien-

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tifically on the development of efficient treatment regimens.

There is evidence that the neuropsychological treatment programs for memory deficits associated with acute brain injuries have effects surpassing the natural course of remission although controlled randomized trials have been rare (das Nair & Lincoln 2007). An arsenal of techniques has become available reaching from functional training, compensation techniques, methods derived from behavioral therapy to the use of external memory aids (for an overview see Cicerone et al., 2002; Rees et al., 2007; Thöne-Otto et al.; 2008).

Accordingly, some training programs focus on one specific memory domain, allowing intensive training of an isolated function, whereas others provide compensational strategies for several everyday memory tasks, not focusing on one single memory process, but improving strategy knowledge and application in patients.

Whatever training procedure is chosen, it is of interest whether the treatment results in domain-specific effects only on the memory process that has been trained or whether generalization to other memory functions or even to other cognitive domains occurs. There is evidence for either ways of effects. Thus, Constantinidou et al. (2005) evaluated a specific categorization training in a sample of patients with traumatic brain injuries. They reported specific effects on a categorization task as well as more generalized effects on functional outcome assessed by questionnaires. In a follow-up study (Constantinidou, Thomas, & Robinson, 2008) the authors compared the categorization training to a control group, who received the conventional treatment used at their rehabilitation center. In this study both treatment groups showed general improvement in several neuropsychological tests as well as in functional outcome, but only the categorization treatment group showed substantial improvement in tests of categorization. Twum and Parente (1994) compared training of an imagery strategy for verbal paired associates with training of a verbal labeling strategy for visual paired associates in patients with closed-head-injuries and found only specific improvements of the trained tasks. The specific effects were also demonstrable at delayed testing.

Few studies, however, so far have directly compared specific memory-process-related programs with more general compensation-related programs with regard to the question of generalization. Hildebrandt, Clausing, Janssen, & Mödden (2007) give an overview of four studies, in which they compared the treatment of the encoding process to the training of various memory strategies. Treatment effects generalized to various untrained aspects of verbal memory performance but not to visual memory and attention. In all branches of treatment effects were highly dependent on the number of training sessions. According to such results, generalization appears to be limited to the near-field of the trained function and independent of the type of the memory training.

The aim of the present study was to replicate and elaborate the findings of Hildebrandt et al. (2007) by comparing a training procedure which focuses on an isolated memory subfunction (namely story recall; Training of Verbal Memory, TVM; Weber, Regel, Krause, & Schulze, 1996) to a training procedure which aims at improving coping strategies for several everyday situations, teaching patients to use internal strategies (e.g., visual imagery or verbal elaboration) as well as external memory aids (Memory Therapy in Groups (MTG; Finauer & Keller, 2007). The hypotheses were that (i) both memory treatments act specifically on memory functions and (ii) the generalization effects are broader for MTG than for TVM.

To test these hypotheses, we examined generalization effects on other cognitive domains, especially on attention (i.e., alertness and divided attention). Attention is a particularly suitable domain for that purpose because unspecific treatment effects can be assumed to be ubiquitous in neurorehabilitation in that any understanding of and adherence to diagnostic and therapeutical demands by the patient relies on this function. Furthermore, we evaluated effects on the memory function trained (i.e., verbal memory) as well as on other memory-related functions (i.e., figural memory). Patients in an inpatient program of neurorehabilitation after acute brain disorder (cerebrovascular, traumatic) served as subjects.

Material and Methods

Subjects

Participants were 27 patients with postacute conditions after ischemic stroke ($n = 21$), intracerebral bleeding ($n = 2$), subarachnoidal bleeding ($n = 2$), traumatic brain injury ($n = 1$) as well as after bacterial and viral encephalitis ($n = 1$) treated as inpatients in a center for neurorehabilitation (Fachklinik Herzogenaurach), of whom 15 were female. The mean age was 63.5 years ($SD = 13.9$ years; range: 24 to 82 years). The time since insult was not allowed to be longer than one year (mean = 54.0 d, $SD = 96.8$ d). The level of education was high school or less in 19 cases and university in 11 cases. To qualify as participant the patient had to suffer from a memory deficit, which was defined as a test score associated with a percentile rank of < 10% in the verbal or/and in the nonverbal part of a memory test (Verbal Learning Test = VLT, Nonverbal Learning Test = NVLT; see below for a detailed description). Patients with the co-morbid occurrence of other CNS disorders, mental disorders, symptoms of aphasia, alexia or disorders of attention were excluded. The patients were informed about the diagnostic procedures and the types of memory treatment offered. In case of interest they signed a consent form. The study protocol was approved by the ethics committee of the medical school of the University in Erlangen.

General Procedure

After admission to the center for neurorehabilitation potential candidates for participation were screened by use of an interview concerning their medical history and the memory tests (VLT, NVLT) for inclusion and exclusion criteria. Patients who were selected for study participation underwent further neuropsychological testing, namely the alertness and divided attention subtest of the Test Battery of Attentional Performance (TAP; see below for detailed description).

Patients were randomly allocated to one of two memory treatments, namely the Training of Verbal Memory (TVM; Weber et al., 1996; $N = 14$) and Memory Therapy in Groups (MTG; Finauer & Keller, 2007; $N = 13$). Randomization was conducted for matched pairs of patients to avoid pretreatment differences between groups. Criteria for matching were age, level of education, type of brain disorder and scores in the memory tests. Accordingly, the two groups did not differ significantly in these variables.

The therapist ran tests before therapy; investigators, who were blind about the training procedure, conducted tests afterward.

Training Procedures

Memory treatment was added to the standard program of neurorehabilitation for patients after acute brain disorder in the rehabilitation center. The standard program included pharmacotherapy (mainly drugs, which lower the risk of cerebro-vascular disorders), physiotherapy, occupational therapy, speech therapy (if necessary), social counseling and neuropsychological treatment. The neuropsychological standard treatment of the patients enrolled in the present study was reduced and did not cover training of memory and attention.

The number of treatment sessions in the study was at minimum 12 and at maximum 15 (mean = 12.8). There was no significant difference in frequency between the two treatment groups. The treatment frequency varied between 4 and 5 sessions per week. Training of Verbal Memory was conducted individually and lasted 30 minutes per session, while the Memory Therapy in Groups took 50 minutes per group session. A student of neuropsychology (first author) conducted all therapies. The student was trained before the study by an experienced neuropsychologist up to the therapeutical standards of the center of neurorehabilitation.

Training of Verbal Memory (TVM; Weber et al., 1996)

The TVM is part of the more comprehensive computer-based training of cognitive functioning called REHACOM. The subprogram TVM aims at improvement of encoding of concrete and abstract verbal material. Concrete and abstract texts were presented on a computer screen. Patients were instructed to read the texts and subsequently to answer multiple choice questions concerning relevant details. After that, patients received immediate feedback concerning their performance. The therapist encouraged the use of memory strategies. Patients were asked to extract relevant information, to categorize information (concerning names, numbers and events of the story), to rehearse relevant information and to use further encoding strategies (e.g., semantic elaborations) if necessary. Task difficulty was adaptively increased, i.e., in case of errors the acquisition phase was prolonged. In case of repeated errors the difficulty level was reduced. After two successful runs the difficultly level was increased. Task difficulty was varied by changing the length of the texts and the number of questions asked.

Memory Therapy in Groups (MTG; Finauer & Keller, 2007)

Memory groups consisted of a maximum of 6 patients and lasted 50 minutes. The therapy sessions consisted of a round of introduction, review of the last session, presentation of the new topics both theoretically and by practical exercises and, finally, the plan for the next session. Training topics, which were presented over the 15 sessions, were

- meta-memory information (education about memory and learning techniques),
- internal memory strategies (verbal elaboration, e.g., PQRST-technique, story-technique for isolated information, visual imagination, exercises in extraction of essential features of memory material),
- practice in the use of external memory aids.

The memory material, which was used for training, consisted of names, digits and stories and was presented auditorily (e.g., radio news) or visually.

Table 1 gives a summary of the main characteristics of the two memory treatments.

Table 1
Summary of the main characteristics of two memory treatments

	Training of Verbal Memory TVM	Memory Therapy in Groups MTG
	Individual	Group of maximal 6 patients
	PC-based	Group interaction
Time	30 minutes	50 minutes
Frequency	12–15 sessions; 4–5 times per week	12–15 sessions; 4–5 times per week
Therapist	Encourages strategy use	Education concerning memory Information about strategies Training of strategy use
Strategies	Organization Verbal elaboration	Organization Verbal elaboration Imagination External memory aids
Material	Texts	Texts, radio news, TV news, names and faces, word lists, digits

Outcome Variables

Memory was tested by use of the *Verbal Learning Test (VLT)* and the *Nonverbal Learning Test (NVLT*; Sturm & Willmes 1999). The two tests were designed in a way that they mainly differed in the memory material but not in the form of presentation. Given that the two subtests consisted of neologisms as well as meaningless figures, the material was supposed to be unfamiliar to all patients before the test, thus avoiding individual differences due to earlier experiences with the memory material.

In the VLT 120 cards with neologisms were presented to the patient. Half of the neologisms were similar to German words, the rest was not. There were 8 runs of 20 cards each. In each run after the first run eight of the neologisms had already been presented in earlier runs. The patients were instructed to classify each neologism as already known or as new. The memory parameter was the difference between the number of hits and false alarms as regards the category "known." There were two parallel forms (A, B), which allowed us to use form A before treatment and form B thereafter.

In the NVLT 120 cards with meaningless figures were presented. Half of them included geometrical elements whereas he other half was made up of irregular pattern of lines. The protocol of the test is apart from the material identical to the VLT. However, there were no parallel forms so that the same form was used before and after treatment.

Attention was tested by used of the *Test Battery of Attentional Performance (TAP*; Zimmermann & Finm, 2002), of which the tests for Alertness (TAP-A) and for Divided-Attention (TAP-DA) were applied. In the *TAP-A* the tonic and phasic forms of alertness were assessed in 80 trials. In the present study only the phasic alertness was registered, which is characterized by the reaction time after a visual stimulus, which is preceded by an auditory warning cue.

TAP-DA consisted of a dual-task paradigm. There were two series presented concurrently consisting of 100 dot patterns on the one hand (visual task) and 200 beeps of different pitches on the other hand (auditory task). The target stimuli were a dot pattern forming a square and two beeps of the same pitch in sequence. The reaction time of correct response was assessed for both types of stimuli.

The median of the individual reaction times in the TAP-A and TAP-DA were used for further computation.

Statistics

The memory and attention parameters were transformed to *t*-scores to allow for comparison between test modalities. The effects of treatment were evaluated by two-factor analysis with one factor "group" (TVM vs. MTG) and one factor "time" (before and after treatment) for repeated measurements. General effects of treatment would lead to significant results for the factor "time" whereas a superiority of one treatment over the other would result into significant interactions between "group" and "time." Potential group differences before treatment due to randomization errors were assessed by t-tests for independent samples. The size of treatment effects was additionally characterized by Cohen's d. The level of significance was set to $\alpha = 0.05$.

Results

The results of the memory tests are shown in Figure 1 and Table 2. As obvious in this figure there were no differences between groups before treatment (all $p > .5$ for the corresponding *t*-tests), suggesting sufficient quality of our randomization procedure.

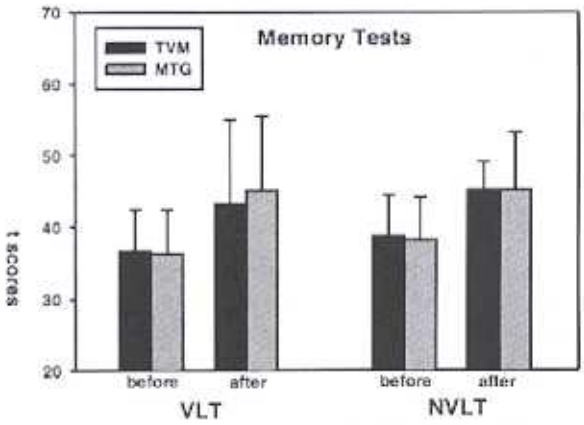

Figure 1. Mean (*pm* ± *SD*) of the memory parameters (VLT, NVLT) before and after memory treatment by TVM and MTG. Treatment effects were significant (VLT: $F(1, 25) = 11.826$, $p = .002$; NVLT: $F(1, 25) = 18.653$, $p < .001$).

There were significant effects of both memory treatments (TVM, MTG) on the memory parameters of the VLT and NVLT (see Figure 1). The general effectiveness of the two memory treatments was proven by significant main effects of "time" (see Table 2). However, the two treatments did not differ from each other.

In contrast, there was no statistical indication of any effects of the memory treatments on the attention tests TAP-A and TAP-DA (see Figure 2 and Table 2). Nor were there any differences in effectiveness between the two treatments in this respect.

The strong effects of the memory treatments on the memory parameters and the weak effects on the attention parameters were again demonstrated by the computation of Cohen's d. Cohen's d marks strong effects by scores above 0.8 and weak effects by scores below 0.5. For this computation the two treatments were combined because of the lack of any indication of significant differences between treatments. The treatment effects on the VLT and NVLT

Table 2
Results of the analyses of variance (F- and p-values) for the effects of the memory treatments (TVM, MTG) on the memory parameters (VLT, NVLT) and the attention parameters (TAP-A, TAP-DA)

	Group	Time	Group × Time
VLT	$F(1, 25) = 0.074$; $p = .787$	**$F(1, 25) = 11.826$; $p = .002$**	$F(1, 25) = 0.265$; $p = .611$
NVLT	$F(1, 25) = 0.031$; $p = .862$	**$F(1, 25) = 18.653$; $p < .001$**	$F(1, 25) = 0.026$; $p = .874$
TAP-A	$F(1, 25) = 0.233$; $p = .633$	$F(1, 25) = 0.594$; $p = .448$	$F(1, 25) = 3.234$; $p = .085$
TAP-D	$F(1, 25) = 0.005$; $p = .945$	$F(1, 25) = 1.949$; $p = .175$	$F(1, 25) = 2.074$; $p = .163$

Significant results marked in **bold**.

Table 3
Cohen's d as measure of the sizes of the effects of the memory treatments combined on the memory parameters (VLT, NVLT) and the attention parameters (TAP-A, TAP-DA)

	VLT	NVLT	TAP-A	TAP-DA
Cohen's d	0.90	1.06	0.17	0.39

d values above 0.2 describe weak, above 0.5 medium and above 0.8 large effects.

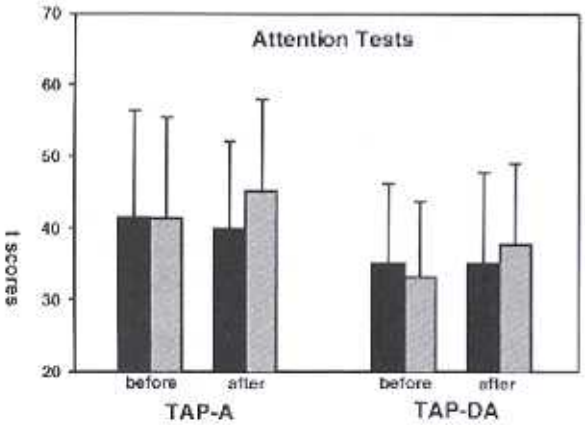

Figure 2. Mean (*pm* ± *SD*) of the attention parameters (TAP-A, TAP-DA) before and after memory treatment by TVM and MTG. Treatment effects were not significant (TAP-A: $F(1, 25) = 0.594$, $p = .448$; TAP-DA: $F(1, 25) = 1.949$, $p = .175$).

performance proved to be strong in both cases (see Table 3), suggesting specific effects on the trained function (verbal memory) as well as near-field generalization effects on the untrained function (figural memory). The effect sizes demonstrated again a lack of generalization effects on attention, since these effect sizes showed no or only weak effects, respectively.

Discussion

The major finding of the present study was that both of our memory treatment programs had sizeable effects on tests of memory. Although we used different kinds of training procedures, one which concentrated on memory for texts only (TVM) and one which consisted of meta-memory training and strategy use for various everyday situations (MTG), there were no differences in the sizes of training effects. Both treatment programs succeeded in improving performance on a test of verbal as well as figural recognition, with similar effects on both types of memory. The beneficial effect on figural recognition suggests near-field generalization within the memory domain because figural memory was not trained specifically. However, training effects were memory specific, because there were no or only weak effects on tests of attention such as alertness and divided attention. Therefore, we conclude that the effects of memory training are "specific" – since memory but not attention is significantly improved – but it is not "hyper-specific," since generalizations on visual recognition tests could be shown.

Looking at the literature, several studies have reported general improvement on memory performance irrespective of the memory training used, but they usually also find specific effects of the training strategies, when using outcome-variables, which measure the specific function. Thus Constantinidou et al. (2008), who compared a categorization training to a conventional treatment used at their rehabilitation center found general improvement in several neuropsychological tests as well as in functional outcome in both groups but only the categorization treatment group showed substantial improvement in tests of categorization.

Hildebrandt, Bussmann-Mork, & Schwendemann (2006) compared two high frequency training groups with a low frequency control-group. In their process-oriented group (POT) the major focus was mass practice on material to be learned, by reliance on constructing a semantic framework and by learning to use spaced retrieval. The Strategy training group (ST) aimed at sensitizing patients for their memory impairment and to increase performance by use of several memory strategies adapted to situational requirements and individual preferences. Again, both training groups improved in verbal and prospective memory but the

POT group showed a higher increase in semantically cued retrieval of the CVLT and a decrease of the forgetting rate in the CVLT.

The third example is a study by Tam and Man (2004), who compared four different methods of computer-assisted memory training (self-paced, feedback, personalized and visual presentation) and a no training control group. Subjects of the training, but not the control group, showed improvements on the training tasks and clinical improvements, although effects on the Rivermead Behavioral Memory Tests (RBMT) were not significant. Training specific effects, however, could be shown for the feedback group, who was the only one which showed significant improvements on a self-efficacy rating scale.

Given these results the question is why our TVM group did not result in higher effects on the verbal memory test (VLT) in comparison to the MTG group. In accordance with Hildebrandt et al. (2007) one might argue that improvement of memory performance depends largely on frequency and intensity of training sessions (which did not differ between our two training conditions) and is not dependent on the specific strategy applied. We think, however, that the fact that we were not able to show training effects in favor of the more specialized training for verbal memory, may also be due to the instruments, which we used for outcome assessment. The Verbal and Nonverbal Learning Task (VLT /NVLT, Sturm & Willmes 1999) provide modality specific tasks, which are equalized concerning task difficulty and requirements. In addition both tasks use material (pseudo-words and figures, which are hard to verbalize), for which former experience can be largely ruled out. Thus they may be regarded as basic memory tests, which are not very prone to strategy use specific for verbal and nonverbal material. In this respect – in line with the findings of Constantinidou et al. (2008) and the other studies mentioned above – our study was able to show that basic memory functions were improved by different kinds of training irrespective of training modality.

Nevertheless, it has to be explained, why a training which focuses on verbal tasks, succeeds in producing significant effects on a figural test memory test, while other authors, such as Hildebrandt et al. (2007) did find generalization effects on nontrained verbal tasks but not on figural memory tasks. The figural task used by Hildebrandt et al. was a map learning task, while we used a pattern recognition procedure whereas both tasks probably also differ in task difficulty. Possibly, the strategies trained in our training groups were able to improve basic processes of recognition memory, which are mirrored both by the VLT and NVLT. If they were able to also show effects on more elaborate tasks such as figural free recall, as required in the map learning task by Hildebrandt et al., remains unclear.

Interestingly, despite of the generalized training effects within the memory domain, effects were still domain specific, given that there were no significant effects on tests of attention. These findings are in line with a study by Ball et al. (2002) who conducted a randomized controlled trial with memory training, reasoning training and speed of processing training vs. control group in healthy elderly people, and who found only specific training effects in the targeted cognitive ability compared to baseline. As can be seen from figures 1 and 2, these differential effects in our study do not depend on differences between the baseline performances in the memory and attention task (all t-tests for dependent samples on differences in the performances between the attention and memory tasks remained insignificant), which might have occurred due to the sample selection procedure. Although we selected patients with mainly memory deficits, they were similarly impaired in attentional tasks.

In closing some weaknesses of our study should be commented on: 1) the limited sample sizes prevented us from computing more sophisticated statistics, which would have sometimes been preferable. Fortunately, our major findings appeared statistically that unequivocal that we would not have expected very different results if larger samples had been analyzed by other statistical tests. 2) Since the study was conducted in a clinical setting, for ethical reasons it was not possible to have a nontreated control-group. A design with multiple baselines, in which a comparison group of patients receives therapy later in the course of the study, can help to overcome this problem when feasible. 3) Therapies were added to a multidisciplinary treatment program including occupational therapy, physiotherapy etc. It is, however, unlikely, that these additional treatments had an effect on our outcome variables, and the two treatment groups did not differ in this respect.

In conclusion, comparing two different memory training procedures, our study was able to show that treatment effects generalized within memory domains but were memory-specific, since no generalization to other cognitive domains were observable. In order to further understand the specificity of different training strategies, studies should use general as well as strategy-specific outcome variables. In addition, patient groups should be selected with careful consideration as to deficits in specific memory processes in order to better understand differential indications of different therapy aspects.

References

Ball, K., Berch, D. B., Helmers, K. F., Jobe, J. B., Leveck, M. D., Marsiske, M., ... Willis, S. L. (2002). Advanced cognitive training for independent and vital elderly study group. Effects of cognitive training interventions with older adults: A randomized controlled trial. *Journal of the American Medical Association, 288*, 2271–81.

Cicerone, K. D., Dahlberg, C., Malec, J. F., Langenbahn, D. M., Felicetti, T., Kneipp, S., ... Catanese, J. (2005). Cognitive rehabilitation: Updated review of the literature from 1998 through 2002. *Archives of Physiological Medicine and Rehabilitation, 86*, 1681–92.

Constantinidou, F., Thomas, R. D., & Robinson, L. (2008). Benefits of categorization training in patients with traumatic brain injury during postacute rehabilitation: Additional evidence from a randomized controlled trial. *Journal of Head Trauma Rehabilitation, 23,* 312–28.

Constantinidou, F., Thomas, R. D., Scharp, V. L., Laske, K. M., Hammerly, M. D., & Cuitonde, S. (2005). Effects of categorization training in patients with TBI during postacute rehabilitation: Preliminary findings. *Journal of Head Trauma Rehabilitation, 20,* 143–57.

das Nair, R., & Lincoln, N. (2007). Cognitive rehabilitation for memory deficits following stroke. *Cochrane Database of Systematic Reviews, 3,* Art. No. CD002293.

Finauer, G., & Keller, I. (2007). Gedächtnistherapie. In G. Finauer (Ed.), *Therapiemanuale für die neuropsychologische Rehabilitation* (pp. 41–100). Heidelberg: Springer-Verlag.

Hildebrandt, H., Bussmann-Mork, B., & Schwendemann, G. (2006). Group therapy for memory impaired patients: A partial remediation is possible. *Journal of Neurology, 253,* 512–19.

Hildebrandt, H., Clausing, A., Janssen, H., & Mödden, C. (2007). Rehabilitation leichter bis mittelschwerer Gedächtnisdefizite – mehr Therapie hilft deutlich mehr, aber welche, wie und warum? *Neurologie und Rehabilitation, 13,* 135–45.

Müller, S. V., Hildebrandt, H., & Sachsenheimer, W. (2000). Analyse des Bedarfs an klinischer Neuropsychologie in der stationären neurologischen Rehabilitation (Phase C und D) – eine empirische Studie an 788 Patienten. *Rehabilitation, 29,* 1–9.

Rees, L., Marshall, S., Hartridge, C., Mackie, D., Weiser, M., & Erabi Group. (2007). Cognitive interventions post acquired brain injury. *Brain Injury, 21,* 161–200.

Sturm, W., & Willmes, K. (1999). *Verbaler und Nonverbaler Lerntest* [Verbal and non-verbal learning test]. Göttingen: Hogrefe.

Tam, S.-F., & Man, W.-K. (2004). Evaluating computer-assisted memory retraining programs for people with posthead injury amnesia. *Brain Injury, 18,* 461–70.

Thöne-Otto, A. I. T., George, S., Hildebrandt, H., Reuther, P., Schoof-Tams, K., Sturm, W., & Wallesch, C.-W. (2008). Diagnostik und Therapie von Gedächtnisstörungen. In H. C. Diener, N. Putzki (Hrsg.), *Leitlinien für Diagnostik und Therapie in der Neurologie. Herausgegeben von der Kommission "Leitlinien der Deutschen Gesellschaft für Neurologie"* (4. Aufl., S. 936–44). Stuttgart: Thieme.

Twum, M., & Parentè, R. (1994). Role of imagery and verbal labeling in the performance of paired associates tasks by persons with closed head injury. *Journal of Clinical and Experimental Neuropsychology, 16,* 630–39.

Weber, P., Regel, H., Krause, A., & Schulze, F. (1996). *Verbales Gedächtnis.* Göttingen: Hogrefe.

Wilson, B. A. (1992). Recovery and compensatory strategies in head injured memory impaired people several years after insult. *Journal of Neurology, Neurosurgery and Psychiatry, 55,* 177–80.

Zimmermann, P., & Fimm, B. (2002). *Testbatterie zur Aufmerksamkeitsprüfung* [A test battery for attentional performance] (Version 1.7). Herzogenrath: Psytest.

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