Occupational Therapy Treatments for Constructional Deficits

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Occupational therapists use both adaptive and remedial approaches to perceptual retraining in adults with head injury. This experimental treatment outcome study compared the effects of adaptive and remedial treatments for constructional deficits on meal preparation competence and on constructional abilities in adult men with head injury. Forty-five subjects, 18 to 52 years of age, in long-term rehabilitation programs were randomly assigned to one of two treatment groups. A remedial group (n = 22) received individual training with parquetry block assembly, and an adaptive group (n = 23) received individual training in food preparation activities. Both groups received training for three 30-min sessions per week for 6 weeks, in addition to their regular rehabilitation programs. Results of analyses of variance and paired t-tests on perceptual and functional test scores showed task-specific learning in both groups and suggested that training in functional activities may be the better way to improve performance in such activities in this population.

Occupational therapists currently follow one of two basic approaches to perceptual retraining—adaptive functional activities training or remedial perceptual skills training (Hopkins & Smith, 1983; Neistadt, 1988; Siev, Freistat, & Zoltan, 1986). Therapists following the adaptive functional activities training approach use treatment tasks such as meal preparation to provide practice in functional activities (Trombly, 1983). Therapists following the remedial perceptual skills training approach use treatment tasks such as puzzle construction to provide clients with practice in deficit perceptual skills that contribute to poor functional performance (Anderson & Choy, 1970; Gregory & Aitken, 1971; Holzer, Stiassny, Senner-Hurley, & Lefkowitz, 1982; Wahlstrom, 1983).

Some treatment outcome studies without control groups have shown that functional training can lead to improved performance in self-care and community living activities for adults with brain injury (Neistadt, 1987; Neistadt & Marques, 1984; Shillam, Beeman, & Loshin, 1983). Other studies with control groups have shown that perceptual skills training with tabletop tasks can lead to improved client performance on functional and perceptual evaluations (Ben-Yishay, Diller, Mandleberg, Gordon, & Gerstman, 1971; Carter, Howard, & O'Neil, 1983; Carter, Oliveira, Dupont, & Lynch, 1988; Diller et al., 1974; Diller & Weinberg, 1977; Leer, 1984). However, to date, no one has compared these two types of training to see if one is more effective than the other in promoting improved functional or perceptual task performance in adults with brain injury.

The purpose of the present study was to compare the effects of training with an adaptive functional activity versus a remedial perceptual skills activity on head-injured clients' performances in perceptual evaluations of constructional ability and in a food preparation task. The question explored was, “Do these different treatment tasks differentially affect constructional and meal preparation skill levels in adult men with head injury?”

Constructional ability—the capacity to assemble parts into a whole (Benton, 1979) — was chosen as the perceptual skills focus because, although this deficit has been identified in adults with head injury (Baum & Hall, 1981; Ben-Yishay & Diller, 1983; Goodglass & Kaplan, 1979; Katz, Itzkovich, Averbuch, & Elazar, 1989; Walsh, 1985), rehabilitation specialists have not studied treatment for constructional deficits in this population.

Literature Review

The functional and perceptual skills training approaches are based on different assumptions about the learning capacities of adults with head injury. The functional approach is based on an assumption that adults with head injury will have difficulty transferring learning across dissimilar tasks, whereas the perceptual skills training ap-
The learning assumption of the functional approach leads to a choice of functional tasks (e.g., meal preparation) as treatment activities. Functional approach therapists would say that because adults with head injury have difficulty transferring learning across different tasks, treatment time should be spent practicing the functional activities that will contribute to independence in the community. The learning assumption of the perceptual skills approach leads to a choice of tabletop tasks (e.g., parquetry block assembly) as treatment activities. Perceptual skills approach therapists would argue that because transfer of learning is possible in this population, treatment time is best spent providing focused training in perceptual skills, because improvement in perceptual skills should lead to improvement in all functional activities requiring those skills.

Some researchers have indicated that adults with head injury are able to transfer that learning only to very similar tasks and have lent support to the learning assumptions of the functional approach. Glisky, Schacter, and Tulving (1986) found, for example, that head-injury clients with memory problems were able to acquire and retain the knowledge to perform a variety of computer functions, including writing and running simple programs. These clients, however, were unable to perform these tasks in response to cues that were different from those used in training and were unable to answer abstract open-ended questions about what they had learned. Si-vak, Hill, and Olson (1984) conducted a pilot study to test the transfer of perceptual skills learned on microcomputer video tasks to paper-and-pencil perceptual evaluations. They found their subjects made little transfer between the training and evaluation tasks and suggested the reason was that there was “no surface similarity” (p. 397) between the two sets of tasks. The difficulty that subjects in these two studies had transferring learning to tasks slightly different from their training tasks suggests a reliance on association learning.

Association learning is the process by which a person “acquires some form of association between two events” (Goldstein & Oakley, 1985, p. 14) and is mediated by subcortical or, in some cases, cerebellar structures in the mammalian brain. Persons engaged in this type of learning are heavily dependent on environmental cues and thus need high similarity of tasks in order to transfer learning from one situation to another. Goldstein and Oakley (1985) suggested that adults with head injury may rely most heavily on association learning, especially in the early stages of recovery. Many other authors have also highlighted the stimulus-bound behavior of adults with head injury (Lezak, 1983; Rosenthal, Griffith, Bond, & Miller, 1983; Walsh, 1985).

If adults with head injury rely on simple association learning, they would have difficulty transferring learning to different tasks. Skills learned in a perceptual skill activity like parquetry block assembly, for example, would not be expected to transfer to a functional activity like meal preparation. Conversely, skills learned in a functional activity would not be expected to transfer to a tabletop perceptual activity. Consequently, training in a perceptual activity would not be expected to effect significant improvement in a functional activity, and training in a functional activity would not be expected to effect significant changes in a tabletop perceptual activity. Therefore, the hypotheses of this study were as follows:

1. A perceptual skills training group receiving training in parquetry block design construction will improve significantly more than a functional training group receiving training in kitchen tasks on tests of block design construction following treatment.

2. A functional activities training group will improve significantly more than a perceptual skills training group on an evaluation of meal preparation skill following treatment.

Method

Design

To address the hypotheses, I used an experimental pretest–posttest design with two treatment groups. An adaptive functional skills training group received individual training in food preparation activities, and a remedial perceptual skills training group received individual training with parquetry block assembly. The independent variable was treatment approach (i.e., functional or perceptual skills training), and the dependent variables were test scores on a Parquetry Block Test (Neistadt, 1989) and the Wechsler Adult Intelligence Scale-Revised (WAIS-R) Block Design subtest (Wechsler, 1981), which measure constructional ability, and on the Rabideau Kitchen Evaluation-Revised (RKE-R) (Rabideau, 1986), which measures meal preparation performance.

Subjects

The sample comprised 45 subjects who (a) were men aged 18 to 55 years; (b) had a condition diagnosed as diffuse brain injury secondary to traumatic head injury or anoxia; (c) were at least 6 months postinjury (to control for the factor of spontaneous recovery); (d) were receiving treatment in long-term rehabilitation programs; (e) had functional use of both arms or were hemiparetic, but not hemiplegic; (f) had at least an eighth-grade education; (g) were functional communicators; (h) showed no unilateral neglect on a line bisection test (to control for the confounding effects of neglect on treatment); (i) had a scaled score of 30 or lower on the pretest WAIS–R Block Design subtest; and (j) had a less than perfect score on
Instruments

Thirty-six subjects came from the former; 9 subjects, from the latter. Information on diagnosis, time since injury, age, and educational level was obtained from the subjects' medical records. Handedness information was obtained through interviews with the subjects.

The average age for the entire sample was 33.2 years (SD = 9.1), and the average length of time since head injury was 7.9 years (SD = 6.6). The average educational level was 11.2 years (SD = 1.8). Forty-two subjects had received diagnoses of traumatic head injury (1 with open head injury and 41 with closed head injury), and 3 subjects were status postanoxia. All subjects were independent in terms of mobility—29 were ambulatory, and 16 used manual wheelchairs. Five subjects were left-handed (4 premorbidly and 1 postmorbidly), and 40 were right-handed (all premorbidly).

The subjects were randomly assigned to either the functional (n = 23) or perceptual skills (n = 22) treatment group. The two groups were comparable in initial perceptual, functional, and coordination test scores and in all demographics except age. The functional group mean age was significantly younger than the perceptual skills group mean age (t = 3.21, df = 43, p = .0025).

**Instruments**

All subjects were given the following pretests: the Line Bisection Test (Lezak, 1983), two subtests of the Jebsen Hand Function Test (Jebsen, Taylor, Trieschmann, Trotter, & Howard, 1969) (Simulated Page Turning and Picking up Small Objects), the WAIS-R Block Design subtest, the Parquetry Block Test (Neistadt, 1989), and the RKE-R. The Line Bisection test was given to screen out subjects with unilateral neglect, and the Jebsen subtests were given to provide descriptive information on the subjects' fine motor status. The remaining three tests were also given as posttests and are described below.

**WAIS-R Block Design subtest.** This subtest was used in the present study because it is a standardized, reliable, valid assessment of constructional abilities in adults. The test involves the construction of block designs of four or nine blocks each from model design cards. Scaled scores that compared the subjects' accuracy and speed with that of nondysfunctional subjects of the same age range were used in this study (Wechsler, 1981).

**Parquetry Block Test.** This test of constructional ability involves the construction of four block designs of 32 blocks each (Neistadt, 1989) from model design cards. The materials were a parquetry set of wooden blocks available from Learning Resources, Inc., with four 9¾-in.-square design cards. The colored cards were manufactured by Learning Resources, Inc.; I made the black-and-white cards by tracing the colored cards. The subjects were told that they could stop this test at any time if they became too frustrated. Fifty-seven percent of the subjects in the functional group and 50% in the perceptual skills group finished all four designs at both pretest and posttest.

I calculated an error ratio for all subjects by dividing the error score by the total number of blocks in the designs attempted (1 determined the error scores by counting the number of incorrectly placed or unplaced blocks in the designs attempted). Error ratios could have ranged from 0 to 1.0, with an error ratio of 0 indicating that all blocks were correctly placed and an error ratio of 1.0 indicating that all blocks were incorrectly placed.

A previous study established means, standard deviations, and minimal and maximal time scores for male and female college students, 18 to 35 years of age, for the designs used in this test. Error ratios for male and female college students ranged from 0 to 0.1, with 98% of nondysfunctional subjects scoring an error ratio of 0 (Neistadt, 1989).

As a test of constructional ability, the Parquetry Block Test is reliable, with a test–retest coefficient of 0.92, and valid, as demonstrated by a significant correlation between the WAIS–R Block Design test and the Parquetry Block error ratio (r = 0.84, p = .0001) (Neistadt, 1991).

**RKE-R.** The RKE-R is a nonstandardized reliable evaluation that is a slight modification of the Rabideau Kitchen Evaluation. On the RKE-R, changes were made in the wording of some items to improve their clarity. The RKE-R requires subjects to prepare a simple meal—a cold sandwich with two fillings and a hot instant beverage. On the evaluation form, the sandwich and beverage tasks are broken down into 40 component steps. These steps are listed in the order in which they are most commonly performed, although the subjects are not required to follow this exact order.

Each component step on the evaluation form is scored according to the following scale:

- 0 = Subject requires no assistance. He or she initiates and performs the component step independently.
- 1 = Subject requires one verbal cue or instruction to perform the component step.
- 2 = Subject requires more than one verbal cue or instruction to perform the component step.
- 3 = Subject is unable to perform the component step and requires direct intervention from the evaluator to complete the step.

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The minimum possible score is 0, which indicates total independence. The maximum possible score is 120, which indicates a need for physical assistance with all steps of the sandwich and beverage tasks.

The evaluation has content validity because it was developed from the occupational therapy literature and was subject to expert review. The RKE-R has a test–retest coefficient of .80 and an interrater agreement of 91% (Neistadt, 1991).

Procedure

I recruited all of the subjects and trained the independent evaluators and therapists. Thirteen of the evaluators were senior-level or master’s-level occupational therapy students, two were registered occupational therapists, and one was a rehabilitation counselor. One other occupational therapist, four of the master’s-level occupational therapy students, and I provided all treatments. All evaluators and therapists had experience with adults with head injury.

Due to unforeseen circumstances, one evaluator was aware of the treatment group assignment of 2 subjects — 1 in each treatment group — at posttest. (Both of these subjects showed marked improvement on all posttest measures.) Otherwise, the evaluators were blind to the subjects’ group assignments, and the therapists were blind to the subjects’ pretest scores during the course of the study.

Evaluation. The subjects were evaluated in their facilities. Any given subject was evaluated at pretest and posttest by the same evaluator. The evaluation battery described above took between 1 and 2 hr per client and was generally conducted in short sessions dispersed over 2-3 consecutive days. The order of tests was based on pragmatic considerations, such as the availability of rooms and subjects. The kitchen evaluations were conducted in occupational therapy kitchens, and the other tests were conducted in quiet areas.

Treatment. The subjects received three 30-min individual treatment sessions per week for 6 weeks in addition to their regular rehabilitation programs. I provided the therapists in this study with written protocols for treatment and 1 to 2 hr of supervision weekly.

All therapists except one treated an equal number of functional and perceptual skills subjects (that one therapist had one more subject in her functional than in her perceptual skills group). The therapists provided training in the preparation of snacks and hot beverages for the functional group and training in parquetry block design construction for the perceptual skills group. The treatment protocols suggested gradations in difficulty for both the snack and parquetry tasks. Gradations of difficulty for the parquetry block tasks were based on information from a previous study (Neistadt, 1989).

For both the snack and parquetry treatments, the subjects started with the easiest level of difficulty and progressed as they achieved competence at successive levels of task difficulty. For subjects who achieved mastery of the highest levels of difficulty before the end of the 6-week treatment period, the snack and parquetry block tasks were further increased in difficulty. Some higher-functioning subjects in the functional group, for example, made more elaborate snacks, such as fruit salads. Some higher-functioning subjects in the perceptual skills group were asked to fit all of the parquetry blocks in the cardboard tray in different ways, without the benefit of a model design card.

The therapists used the same cuing procedure with all subjects. For both the snack and parquetry tasks, subjects’ approaches to tasks were observed and reflected back to them by the therapist. When subjects encountered difficulties, the therapists engaged in mutual problem solving with them to find strategies to improve performance. The problem-solving process was guided by the following questions: (a) What do you see? What looks most obvious to you (about the task or task environment)? and (b) Does what you see suggest the steps you need to take to complete the task? The subjects were also given verbal examples of how to apply the strategies they were using in treatment to other activities.

Results

To address this study’s hypotheses, I performed a series of analyses of variance (ANOVAs) and paired t tests. Although the two treatment groups were significantly different in age, age was not used as an independent variable in the ANOVAs presented here because (a) age did not correlate significantly with the pretest scores for the Parquetry Block Test, WAIS-R Block Design, or RKE-R (r = −.06, p = .71; r = .03, p = .86; r = −.21, p = .17, respectively), and (b) ANOVAs that included age as a two-level (old/young) independent variable did not show any significant age or age-by-treatment interaction effects for any of the posttest measures. Therefore, ANOVAs with simpler models were done to test the hypotheses. A .05 alpha level was adopted for all analyses.

The treatment effect sizes (r) associated with the ANOVAs and t tests were also calculated. Mean pretest, posttest, and change scores for the constructional and functional tests are shown in Table 1. (Change scores were calculated through subtraction of the pretest from the posttest scores.)

The Effect of Treatment on Constructional Test Performance

To test Hypothesis 1, that the perceptual skills group
would improve significantly more than the functional group on the constructional evaluations after treatment, I performed two repeated-measures ANOVAs, one with pretest and posttest scores on the Parquetry Block Test as the repeated measure and another with pretest and posttest scores on the WAIS-R Block Design test as the repeated measure. Both analyses used treatment groups (functional or perceptual skills training) as the between-subjects factor.

Parquetry Block Test. Because subjects were told they could stop the Parquetry Block Test at any time during this test, some subjects completed different numbers of designs at pretest and posttest. Consequently, error ratio scores were not based on the same number of pretest and posttest designs for all subjects. To address this issue, for subjects completing less than four trials at either pretest or posttest, error ratios scores were recalculated based on the minimum number of trials completed by each subject at either pretest or posttest. For example, if a subject completed two trials at pretest and four trials at posttest, then his or her posttest error ratio was recalculated based on his or her first two posttest trials only. These new error ratios were the posttest scores used in the Parquetry Block Test repeated-measures ANOVA.

Hypothesis 1 was supported for the Parquetry Block Test. The perceptual skills group improved significantly more than the functional group on the Parquetry Block Test after treatment (Wilks's lambda F(1, 43) = 4.63, one-tailed p = .0185). The effect size associated with this analysis was .31, which is a medium effect, in the predicted direction.

WAIS-R Block Design subtest. The first hypothesis was not supported for the WAIS-R Block Design subtest. There was no significant difference between the two groups in improvement on the WAIS-R Block Design subtest after treatment (Wilks's lambda F(1, 43) = .71, one-tailed p = .2014). The effect size was .13, which is less than small and contrary to the predicted direction, with the functional group improving more on the WAIS-R Block Design subtest after treatment than the perceptual skill group.

The Effect of Treatment on Functional Test Performance

To test Hypothesis 2, that the functional group would improve significantly more than the perceptual skills group on the RKE-R after treatment, I performed a repeated-measures ANOVA, with pretest and posttest scores on the RKE-R as the repeated measure and treatment group (functional or perceptual skills training) as the between-subjects factor. There was a nonsignificant trend in the expected direction to support the second hypothesis. Although there was no statistically significant difference between the two groups in improvement on the RKE-R after treatment (Wilks's lambda F(1, 43) = 2.25, one-tailed p = .0705), the small to medium effect size (r = .22) associated with this analysis was in the predicted direction, with the functional group improving more than the perceptual skills group on the RKE-R after treatment.

Comparison of Dependent Variable Measures

Paired t tests done on the pretest and posttest scores to examine change for the Parquetry Block, WAIS-R Block Design, and RKE-R Tests provide another illustration of the patterns of functional and perceptual skills training effects on the constructional and functional outcome measures (see Table 1). These analyses showed that treatment for the perceptual skills group had the largest effect on the Parquetry Block Test change scores and the smallest effect on the RKE-R change scores, in the predicted directions (i.e., the subjects in the remedial group did better on the constructional tests than on the RKE-R after treatment). The difference between the Parquetry Block Test and RKE-R effect sizes was significant (Wilson's version of Hotelling's t = 2.40, df = 19, p < .025), as was the difference between the WAIS-R Block Design subtest and the RKE-R.
and RKE-R effect sizes (Wilson's version of Hotelling's $t = 2.17, df = 19, p < .025$) (Steiger, 1980). The functional group treatment had the largest effect on the RKE-R change scores and the smallest effect on the Parquetry Block Test change scores, in the predicted directions, that is, subjects in the functional group did better on the functional than on the constructional tests after treatment, although change on the WAIS-R was also significant in this group. There were no significant differences between the effect sizes for the dependent variables in the functional group.

Discussion

A pattern of training-specific learning is suggested by the treatment effects for the Parquetry Block Test and RKE-R posttest and change scores. Treatment effects were medium and significant for the Parquetry Block Test and small to medium, though nonsignificant, for the RKE-R, in the predicted directions. The perceptual skills group performed significantly better than the functional group on the Parquetry Block Test after treatment, and the functional group performed better than the perceptual skills group on the RKE-R after treatment. The perceptual skills group showed significant change on the Parquetry Block Test but not on the RKE-R after treatment, whereas the functional group showed significant improvement on the RKE-R but not on the Parquetry Block Test after treatment. Given these trends, the improvements seen in other test scores for the two treatment groups probably reflect practice effects from pretest to posttest rather than transfer of learning.

This pattern of task-specific learning corroborates the findings of other investigators who have found task-specific learning in adults with head injury (Glisky et al., 1986; Sivak et al., 1984). The perceptual skills learning in the present study was so task specific that there was no transfer from parquetry block training to WAIS-R Block Design performance, even though the Parquetry Block and WAIS-R Block Design Tests are highly correlated ($r = .84, p = .0001$) (Neistadt, 1991). Though both tests involve the construction of block designs from a design card, the tests use different blocks and require different responses. The WAIS-R Block Design test requires subjects to rotate the blocks in three dimensions to find the appropriate block face; the parquetry blocks do not have multiple block faces and so do not have to be turned over to a correct position before they are placed. These dissimilarities may explain why the subjects in the perceptual skills group did not improve significantly more than the functional group on the WAIS-R Block Design test.

One possible explanation for training specificity is that most subjects relied heavily on association learning, as Goldstein and Oakley (1985) have suggested. The cueing method used in this study was meant to help subjects learn a general strategy of problem solving in approaching difficult tasks. The results suggest, however, that most subjects did not learn a general strategy of task analysis and approach planning from this training. Instead, they seemed to learn a series of responses to specific stimuli in the treatment environments. When the environmental cues changed even slightly, as they did between the treatment and posttest situations, the subjects' task performances often degenerated.

Some subjects, for example, had progressed to the highest level of parquetry design difficulty in perceptual skills treatment but were not willing to try this level of design difficulty at posttest, when they had to work on slightly different designs with someone other than their therapist. Likewise, some functional group subjects had nearly achieved independence during treatment in making themselves instant coffee from a jar. During the posttest, when individual packets of instant coffee were used and the subjects had to work with someone other than their therapist, some of these nearly independent subjects needed a lot of assistance.

Toglia (1991) has suggested that transfer of learning does not happen automatically and must be consciously taught through the practice of targeted strategies in "multiple environments with varied tasks and movement demands" (Toglia, 1991, p. 506). The treatment protocols used in this study suggested gradations or variations in the treatment tasks used and called for the provision of verbal examples of how subjects could transfer strategies to other tasks. However, the focus on one type of activity for each group clearly fostered task-specific learning. Greater variation in treatment activities might have resulted in greater transfer of learning for both groups.

The RKE-R's limited sensitivity to the functional deficits of higher-level subjects was one limitation of this study. Though the worst possible score on this evaluation is 120, no subject in this study scored above 79. Approximately 22% of the sample scored between 1 and 4—close to a perfect score of 0—even though all of the subjects required rehabilitation programs. This might suggest that the task used in this evaluation—preparation of a sandwich and hot beverage—was too easy for some subjects. Perhaps the use of a more difficult task for evaluation would have brought out the more subtle functional difficulties of high-level subjects. Dobie (1991), for example, reported that a Rasch model assessment of the relative difficulty of different functional tasks showed that the making of a fruit salad was more challenging than the making of a peanut butter and jelly sandwich. The limited sensitivity of the RKE-R may account for the lack of significance in treatment effects for the functional training group.

Another study limitation was the lack of a control group, which would have provided information about how each of these treatment approaches compares to a placebo treatment situation. Yet another limitation was the confounding effect of the rehabilitation programs in
which subjects were engaged during this study. Finally, the evaluation of only one functional task—meal preparation—did not provide any information about whether functional skills training might transfer to related functional tasks.

Conclusion

The results of this study suggest that learning in adult males with head injury, 6 months or more after onset of the injury, is task-specific after relatively short (6-week) training periods. This specificity of learning supports the learning assumptions of the functional approach and suggests that the best way to facilitate improved functional activity performance in this population is to provide training in those specific activities.

The application of this finding to practice needs to be tempered by two considerations. First, although experimental study of groups of clients is a valuable source of information about the effectiveness of practice methods, group studies do not tell us how individual clients will respond to given treatment approaches. Initial perceptual competence levels, learning capabilities, and clients’ interest in particular activities can all influence individual clients’ responses to particular treatments. Any recommendation that a therapist might make to a client about treatment approaches should take these factors into account.

Second, the results of this study cannot be generalized to women, acute clients, or other age or diagnostic groups. Further study is needed to see if these results would be replicated with client populations other than the one researched here. Further study is also needed to replicate this study with an adult male head-injury population to explore whether functional training can transfer between similar functional tasks and to delineate the different learning strategies of adults with head injury. Only through continued research can we hope to learn more about which treatment methods work best for whom and under what conditions—and why.

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