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Neurocognitive enhancement therapy with work therapy in schizophrenia: 6-month follow-up of neuropsychological performance

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Abstract—Cognitive deficits are a major determinant of social and occupational dysfunction in schizophrenia, and new treatments are needed that address these impairments. The current study determined whether neurocognitive enhancement therapy (NET) in combination with work therapy (WT) would show improvement in performance on neuropsychological tests that endured 6 months after completion of training. A total of 145 participants with schizophrenia or schizoaffective disorder were randomly assigned to NET + WT or WT alone. NET included computer-based training on attention, memory, and executive function tasks. WT included paid work activity in job placements at the medical center. Neuropsychological assessment was performed at baseline, at the end of the 6-month active intervention, and 12 months after training began. Repeated measures multivariate analyses of variance revealed greater neuropsychological improvements on working memory ($p < 0.05$) and executive function ($p < 0.05$) for the NET + WT group over the 12 months. Both groups showed sustained improvements on verbal and nonverbal memory.

Clinical Trial Registration: ClinicalTrials.gov, NCT00430560; <http://clinicaltrials.gov/>.

Key words: cognition, neurocognition, neuropsychology, psychosis, rehabilitation, remediation, schizoaffective disorder, schizophrenia, vocational rehabilitation, work therapy.

INTRODUCTION

Recent reviews of the efficacy of cognitive rehabilitation as a method to improve cognitive functioning in schizophrenia have generally been positive [1–6], although one review was equivocal [7]. The remediation of cognitive deficits is potentially clinically significant because cognitive abilities have been shown to be related to self-esteem, work success, skills acquisition, independent living, and quality of life [8–9]. A key question for judging the clinical value of cognitive remediation is whether gains made during training endure beyond the training period. If such gains do not endure past the training phase, it is

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Abbreviations: BLERT = Bell Lysaker Emotion Recognition Test, CFA = Cognitive Function Assessment, CPT = Continuous Performance Test, DSM-IV = Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition, HVLT-R = Hopkins Verbal Learning Test-Revised, MANOVA = multivariate analysis of variance, NET = neurocognitive enhancement therapy, SD = standard deviation, VA = Department of Veterans Affairs, WAIS-III = Wechsler Adult Intelligence Scale-3rd Edition, WBI = Work Behavior Inventory, WCST = Wisconsin Card Sorting Test, WMS-R = Wechsler Memory Scale-Revised, WT = work therapy.

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unlikely that they would generalize to other areas or that they would significantly affect the impact of other psychosocial interventions that rely on adequate processing and retention of presented material. This study investigates the durability of performance effects on standard neuropsychological tests 6 months after completion of neurocognitive enhancement therapy (NET) [10], a 26-week cognitive training program.

Only a handful of reports have been published on the durability of cognitive training effects. Many of these have focused on the durability of gains achieved during training on a single task (e.g., Wisconsin Card Sorting Test [WCST] or Span of Apprehension) and, in general, indicate that improvements are sustained, although follow-up periods have been relatively brief, 6 weeks at most [11–15]. In a longer follow-up study of training effects for two computerized memory training tasks, we reported that gains made on these tasks were sustained at a 6-month follow-up [16]. In another study, Wexler et al. noted that trained-task gains were sustained at a 6-month follow-up for half the patients (three of six) who returned for follow-up testing after a 10-week remediation program of visual reading, dot localization, and manual dexterity tasks [17]. Combined, these studies support the durability of task-specific training effects. Far less is known about whether cognitive remediation gains generalize to untrained tasks and whether those improvements, in turn, are sustained. This question is important, because the overall goal of cognitive remediation programs is to improve general cognitive function, not just performance on the trained tasks.

Medalia et al. reported that a 5-week problem-solving remediation program was associated with sustained improvements on problem-solving tasks at a 4-week follow-up [18]. In another arm of the study [19] during which participants completed a 5-week memory remediation course using computer-based educational software, while trained tasks improved, these improvements did not generalize to untrained tasks, as assessed at a 4-week follow-up. In contrast, Corrigan et al. reported that a single session of memory and vigilance training with a social cue recognition test was associated with sustained improvements on an untrained cue recognition test administered 2 days later [20]. Several other studies are also encouraging, suggesting that improvements on untrained tasks may persist as long as 6 months following training. Wykes et al., for example, reported that gains on a verbal memory task made following a 40-session course of cognitive remediation training were maintained at a 6-month follow-up [21]. Similarly, our research team has reported that a 6-month cognitive remediation program was associated with improvements on an untrained working memory task and that these improvements were sustained at a 6-month follow-up [22].

In 2001, we demonstrated that an integrated work therapy (WT)/cognitive rehabilitation program (NET) resulted in significant cognitive improvements for people with schizophrenia or schizoaffective disorder [10]. In a randomized controlled study, participants were enrolled in either NET + WT or WT only. At study entry, both groups performed poorly on neuropsychological testing. Participants receiving NET + WT showed greater improvements than those receiving WT on pre- and posttestings of executive function and working memory. As many as 60 percent of those in the NET + WT group improved on some measures and were more likely to show large effect-size improvements. The number of participants with normal working memory performance rose significantly with NET + WT, from 45 to 77 percent, compared with a drop from 56 to 45 percent for those in WT. As with other cognitive rehabilitation programs, these results were based on assessments made at the end of the active phase of the intervention. Subsequently, we reported that participants in NET + WT worked more hours than those in WT, with differences emerging during the 6 months following the active intervention [23]. We also found that improvements in work functioning were greatest for those who responded to the NET training by reaching normal levels of performance on a trained working memory task. These results indicated that work outcomes could be influenced by NET + WT training even after the treatment had ended. Whether (1) neuropsychological benefits could also be sustained 6 months after training or (2) discontinuation of training had led to significant declines in cognitive performance, remained to be seen.

Based on our previous findings that improvement in cognitive performance on NET-trained tasks endured to follow-up [16] and that work outcomes differentially improved for NET + WT during follow-up [23], we expected this would be the case for NET + WT effects on neuropsychological performance. Specifically, we hypothesized that executive function and working memory gains observed at the end of treatment would still be detectable 6 months later.

METHOD

Participants

After being referred by their clinicians, 145 participants with schizophrenia or schizoaffective disorder, as determined by psychologists using the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition (DSM-IV) procedures [24], enrolled in our study. All provided written informed consent. Participants were in treatment at the Department of Veterans Affairs (VA) Connecticut Healthcare System in West Haven or the Connecticut Mental Health Center in New Haven. The local institutional review boards at both facilities reviewed the study. Data were collected from 1998 to 2003. Participants were not considered sufficiently stable to participate if they had a change in psychiatric medications or housing in the last 30 days, an episode of drug abuse within the past 30 days, or a Global Assessment of Functioning scale score ≤ 30. Known neurological disease and developmental disability were also cause for exclusion. All participants were receiving antipsychotic medication before and throughout the study. Of the total, 22 percent were receiving a typical antipsychotic only, 70 percent an atypical antipsychotic only, and 8 percent were receiving both, with comparable proportions and dosages for NET + WT and WT conditions.

Retention rate was 91 percent at 6-month follow-up and 80 percent at 12-month follow-up. No significant differences existed in attrition rate by condition at either follow-up point. Of the 145 participants who completed intake assessments and were randomized, neuropsychological test data were available for 132 at 6-month follow-up, and for 116 at both the 6- and 12-month follow-ups. Comparison of the 80 percent of participants with complete follow-up data and the 20 percent without complete follow-up data on background, illness, and neuropsychological intake variables (see **Table** for list of variables) failed to reveal any differences, suggesting that differential attrition based on these variables did not occur.

Baseline and Follow-up Assessments

Neuropsychological testing for pre- and postcomparisons consisted of (1) Digit Span, Letter Number Sequencing, and Digit Symbol Substitution Task from the Wechsler Adult Intelligence Scale-3rd Edition (WAIS-III) [25]; (2) Visual Reproduction I and II, Figural Memory, and Logical Memory I and II from the Wechsler Memory Scale-Revised (WMS-R) [26]; (3) the Hopkins Verbal Learning Test-Revised (HVLT-R), a measure of verbal learning and temporal lobe dysfunction [27]; (4) the Continuous Performance Test (CPT), X/A version (in which the participant is asked to press the space button anytime he or she sees an “X,” immediately followed by an “A” flash on the computer screen), a measure of sustained attention [28]; (5) WCST, a measure of perseveration and flexibility of abstract thought [29–30]; (6) Bell Lysaker Emotion Recognition Task (BLERT), a measure of the ability to identify affect cues in videotaped stimuli [31]; (7) Gorham’s Proverb Test, a measure of thought disorder [32–33]; (8) Hinting Task, a measure of social inference [34]; and (9) Trail Making Test Part B, a measure of cognitive flexibility and psychomotor speed [35]. These measures have established reliability and validity and are sensitive to the types of deficits associated with schizophrenia.

Intervention

Work Therapy

WT consisted of (1) payment for work activity at the rate of \$3.40 an hour for up to 15 hours a week with increasing bonus pay (\$3.90 to \$8.40) for 16 to 20 hours; (2) job placement at the medical center; (3) individual counseling when problems arose; (4) a group offering support, problem-solving, goal-setting, and detailed work performance feedback based on the Work Behavior Inventory (WBI) [36]; (5) a job coach for job-related difficulties and individual vocational counseling; (6) a certificate of participation in the program; and (7) referral to other vocational services on completing the 6-month active phase. The most common work sites were in dietetics, mail room, grounds, maintenance, patient transport, and medical administration, with duties similar to those of entry-level employees supervised by regular medical center personnel.

Neurocognitive Enhancement Therapy

NET consisted of (1) cognitive exercises for up to 5 hours a week for 26 weeks; (2) feedback from the Cognitive Function Assessment (CFA), a rating of work-related cognition [37] in the support group; and (3) a weekly social information-processing group. In addition to up to 5 hours of cognitive exercises, participants in NET could also participate in up to 15 hours of WT (as described previously), for a maximum of 20 hours productive activity. Pay structure and maximum hours of productive activity were equivalent between the conditions

Table.
Background and treatment characteristics.*

Variable	NET + WT (*n* = 53)	WT (*n* = 63)
Age (mean ± SD)	41.9 ± 9.9	43.6 ± 8.1
Sex, Male, *n* (%)	40 (75.6)	50 (79.4)
Marital Status, *n* (%)		
Single	36 (67.9)	41 (65.1)
Married	5 (9.4)	6 (9.5)
Divorced	11 (20.8)	15 (23.8)
Widowed	1 (1.9)	1 (1.6)
Race/Ethnicity, *n* (%)		
White	34 (64.2)	40 (63.5)
African American	17 (32.1)	20 (31.8)
Hispanic	0 (0)	1 (1.6)
Asian	2 (3.8)	2 (3.2)
Schizophrenia Diagnosis, *n* (%)		
Paranoid	24 (45.3)	35 (55.6)
Undifferentiated	1 (1.9)	2 (3.2)
Disorganized	6 (11.3)	4 (6.4)
Residual	6 (11.3)	2 (3.2)
Schizoaffective	16 (30.2)	20 (31.8)
WAIS-Global (mean ± SD)	88.4 ± 12.9	89.4 ± 13.6
Education, yr (mean ± SD)	13.4 ± 2.1	13.3 ± 2.2
Age of Onset, yr (mean ± SD)	21.8 ± 8.0	22.3 ± 7.0
Age at 1st Hospitalization (mean ± SD)	25.1 ± 7.3	25.9 ± 7.2
No. of Lifetime Hospitalizations (mean ± SD)	8.6 ± 12.9	9.2 ± 8.7
Positive and Negative Syndrome Scale (mean ± SD)		
Total	76.5 ± 16.3	77.8 ± 13.3
Positive Component	18.4 ± 5.6	19.4 ± 5.2
Negative Component	20.7 ± 7.1	20.4 ± 5.2
Cognitive Component	18.5 ± 6.4	17.5 ± 5.1
Hostility Component	7.6 ± 3.0	8.3 ± 3.2
Emotional Discomfort Component	11.3 ± 3.0	12.3 ± 2.6
Antipsychotic Medications, *n* (%)		
Typical	12 (22.6)	10 (15.9)
Atypical	32 (60.4)	46 (73.0)
Both	8 (15.1)	5 (7.9)
None	1 (1.9)	2 (3.2)
Medication Dose (Chlorpromazine equivalent) (mean ± SD)	782.0 ± 589.7	628 ± 388

*No statistical differences ($p < 0.05$) existed between conditions on any of these variables.
NET = neurocognitive enhancement therapy, SD = standard deviation, WAIS = Wechsler Adult Intelligence Scale, WT = work therapy.

(i.e., participants were paid for both WT and participation in cognitive exercises).

CFA feedback was given biweekly (at the same time as the WBI feedback) and consisted of job ratings of attention, memory, and executive function. Participants were also encouraged to develop goals based on their WBI and CFA feedback.

Cognitive exercises involved repeated practice on computer-based exercises for attention, memory, and executive function and a dichotic listening task. Participants attended up to five 1-hour sessions a week. Cognitive exercises used a modified form of CogReHab software (Psychological Software Services Inc, Indianapolis, Indiana), a multimedia cognitive rehabilitation software designed for use with individuals with compromised brain function [38]. Parameters were initially made easy enough for each participant to succeed. As soon as the participant achieved 90 percent accuracy at a given difficulty level, the task was made more difficult following a prearranged hierarchy. In that way, while the tasks were challenging enough to not become boring, they also were not unduly frustrating. Along with these computer-based tasks, participants also were trained in a dichotic listening task that involved listening to brief segments of a story (*A Bell for Adano*, by J. Hersey) in the left ear while a distracter of poetry reading was played in the right ear. Participants were asked questions about the content of the story segment. Progress involved correctly answering questions with increasing loudness of the distracter and longer story segments. Details of the tasks are described in Bell et al. [10] and Fiszdon et al. [39].

Procedures

Following informed consent, baseline neuropsychological testing was performed over two or three sessions. Follow-up neuropsychological assessments were conducted at 6 months from intake (at the end of the active intervention) and 12 months after baseline (6 months following active intervention). Psychologists trained specifically in study methods performed all procedures. Following baseline testing, participants were stratified based on severity of cognitive impairment and randomly assigned to 6 months of either NET + WT or WT only. Severe cognitive impairment was based on six key neuropsychological indicators in four cognitive domains. Attention was represented by the number of wrong answers on the CPT; memory by HVLT-R trial 1 and WMS-R Figural Memory; executive function by WCST categories correct and Gorham's Proverbs bizarreness score; and affect recognition by BLERT score. To meet criteria for severe cognitive impairment, a participant had to have scored 1 standard deviation (SD) below the mean (established for a VA sample of schizophrenia participants) on at least two of the six indicators. Of participants in the sample, 43 percent met these criteria.

Data Analysis

Neuropsychological assessment involves many tests, and many of the tests generate multiple variables. Our data reduction strategy was to enter these variables into a principal component analysis with varimax rotation. This procedure yielded four factors with eigenvalues above 1.0 that were found to be clinically coherent. We labeled these "working memory," "verbal and nonverbal memory," "thought disorder," and "executive function." Working memory included raw scores from the WAIS-III Digits Forward and Digits Backward, scaled scores for the letter number sequencing, and total score for the BLERT. Verbal and nonverbal memory included raw scores from the HVLT-R trials 1 and 3, percentile equivalents for WMS-R Visual Reproduction I and II, raw scores for WMS-R Figural Memory and CPT score. Thought disorder included Gorham's Proverbs bizarreness score, the Hinting Task total score, and the WMS-R Logical Memory I and II percentile equivalents. Executive function included number of categories correct, percent perseverative errors, percent nonperseverative errors, and percent conceptual level from the WCST and time from the Trail Making Test Part B. Rather than rely on factor scores that are not easily replicable by other investigators, we opted to group our neuropsychological variables based on their shared variance as indicated by the factor structure into clusters to be used in multivariate analysis of variance (MANOVA). We entered data from intake, 6-month, and 12-month assessments into repeated-measures MANOVA to examine condition effects, time effects and time by condition effects, and one analysis for each of the four clusters of neuropsychological variables. Significant repeated-measures MANOVAs were followed by post hoc linear trend analyses for examining effects of individual variables. All tests were two-tailed, and alpha was set at 0.05.

RESULTS

No significant differences were found between NET + WT and WT participants at baseline for illness, treatment, or background characteristics (**Table**). Individuals in the NET + WT condition participated in a mean ± SD 47.1 ± 40.3 computerized training sessions.

Repeated-measures MANOVA for the executive functioning cluster revealed a nonsignificant condition effect ($F_{4,109}$ = 1.36, p = nonsignificant), a significant time effect ($F_{8,105}$ = 2.68, $p < 0.01$) and a significant condition by time interaction ($F_{8,105}$ = 2.03, $p < 0.05$). Linear trend analyses indicated significant time by condition linear trends for WCST categories correct ($F_{1,112}$ = 5.54, $p < 0.05$) and percent conceptual level ($F_{1,112}$ = 7.46, $p < 0.01$).

Repeated-measures MANOVA of the working memory cluster also demonstrated a nonsignificant condition effect ($F_{6,90}$ = 1.4, p = nonsignificant), a significant time effect ($F_{12,84}$ = 2.96, $p < 0.01$), and a significant condition by time interaction ($F_{12, 84}$ = 2.21, p < 0.05). Condition by time interactions were found (linear trends) on Digits Backward ($F_{1, 95}$ = 4.25, p < 0.05) and Digit Symbol ($F_{1, 95}$ = 3.98, p < 0.05).

For the verbal and nonverbal memory cluster, Repeated-measures MANOVA showed a nonsignificant condition effect ($F_{6, 103}$ = 1.23, p = nonsignificant), a significant time effect ($F_{12, 97}$ = 4.2, p < 0.001), and a trend for the condition by time interaction ($F_{12, 97}$ = 1.77, p = 0.065). Post hoc linear trend analyses indicated a significant time effect for HVLT-R Trial 1 ($F_{1, 108}$ = 23.9, p < 0.001), HVLT-R Trial 3 ($F_{1, 108}$ = 13.8, p < 0.001), and Visual Reproduction II ($F_{1, 108}$ = 16.6, p < 0.001), indicating that participants in both conditions improved, but we saw no significant overall differences in improvement between the two conditions.

For the thought disorder variables, we found a nonsignificant condition effect ($F_{4, 101}$ = 2.38, p = nonsignificant), a significant time effect ($F_{8, 97}$ = 3.02, p < 0.01), and a nonsignificant condition by time interaction ($F_{8, 97}$ = 1.43, p = nonsignificant). Post hoc linear trend analyses of Logical Memory I ($F_{1, 104}$ = 14.9, p < 0.001) and Logical Memory II ($F_{1, 104}$ = 20.8, p < 0.001) indicated significant improvements for all participants over time on these variables.

Visual inspection of performance data suggested several different patterns of change for neuropsychological variables, with change occurring only during the active phase for some variables and, for others, continuing change during the 6-month follow-up. Patterns of change also differed by condition, with some variables associated with equal improvements for both groups and other variables associated with improvement only for the NET + WT group.

Given the already high number of comparisons and the risk of Type I error, we did not further explore these patterns statistically; however, for purposes of discussion, exemplars of the different patterns observed are presented in the **Figure**.

DISCUSSION

This study expands on our previous work regarding the immediate effects of NET + WT on neuropsychological function in schizophrenia by examining the durability of improvements 6 months after the end of the active intervention [8]. Results indicate that participants in NET + WT showed significantly greater improvements in executive function and working memory over 12 months than participants receiving WT only. Post hoc analyses showed that specific significant changes occurred on WCST conceptual level and categories correct variables as well as on the WAIS-III subtests Digit Symbol and Digits Backward. Results also indicate that for the sample as a whole, improvements occurred over 12 months in verbal and nonverbal memory. Post hoc analyses indicated significant improvements over time on HVLT Trials 1 and 3, Visual Reproduction II, and Logical Memory I and II.

Visual inspection of the data suggested two different patterns of performance change over time. For several of the variables, the bulk of improvement occurred at the end of the active phase and was sustained at follow-up 6 months later; for other variables, the gains made during the active phase were further enhanced during the 6-month follow-up period. Although exploratory and only appropriate for hypothesis generation, this latter pattern of performance change is provocative because it suggests that the effects of the NET training may confer greater capacity to use other rehabilitation experiences that continue to enhance cognition. Although NET training stopped at 6 months, most participants continued to participate in work activity, and it may be that working, with its many cognitive demands, stimulated cognitive functioning that had already been enhanced by the NET training.

Evidence for this explanation may be found in the unexpected result that WT alone may have also led to durable cognitive improvements. This study did not include a “treatment as usual” condition to compare with the two active conditions that included WT, so we cannot conclusively judge the time effects we observed. However, the improvements in verbal and visual memory raise the possibility that WT alone may be associated with durable improvements in memory. To our knowledge, no previous literature suggests that WT alone yields neuropsychological improvements.

If WT alone can improve cognitive performance, perhaps the improvement can be explained by the cognitive demands at work. Successfully engaging in a WT program requires an individual to remember such things as time of work shifts, coworker names, location of timecards, sequences of tasks to be accomplished, etc., all of which require exercising memory function. Also, in addition to the work component, our WT program consisted of a work feedback group, and this group may have had an unexpected cognitive impact. In this group, participants

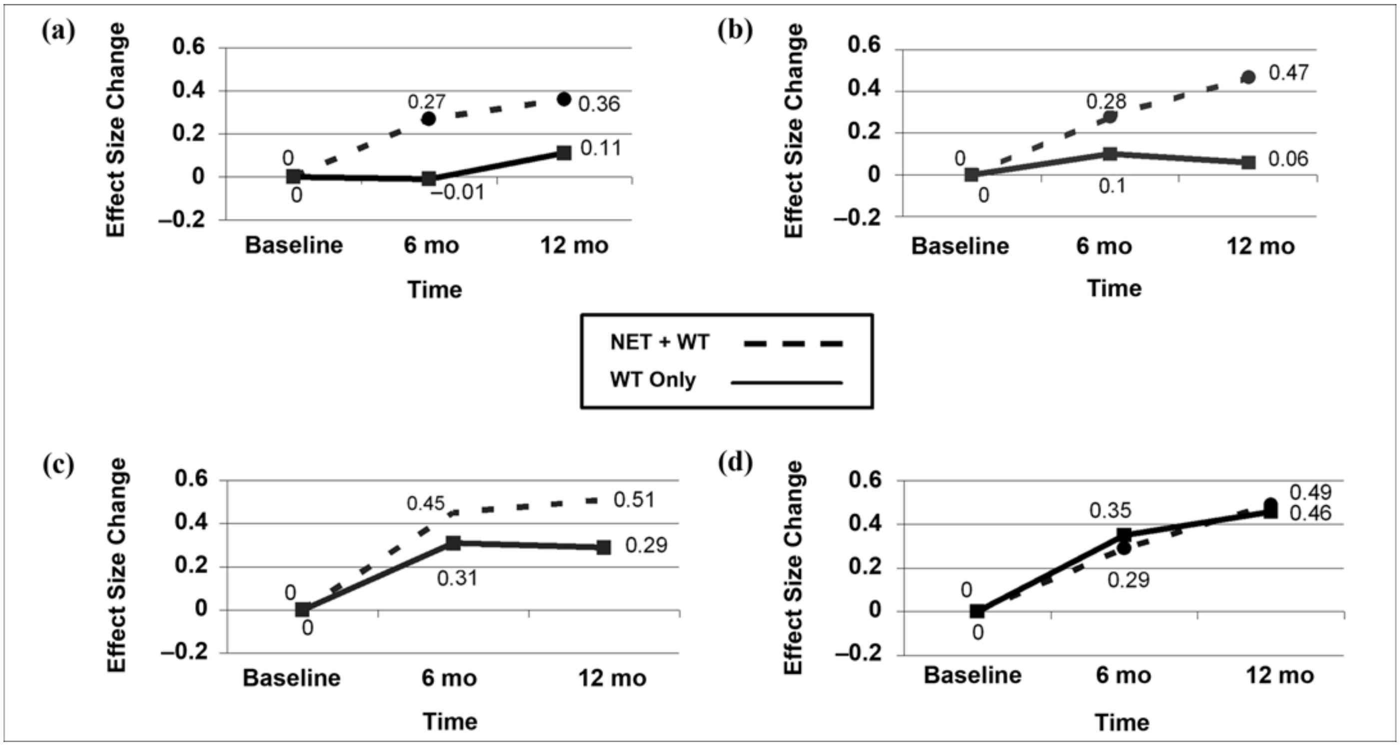

Figure.
Patterns of effect size changes over time by condition: **(a)** WCST % Conceptual Level: NET + WT improvement at 6 months, maintained at 12 months; **(b)** Digits Symbol: NET + WT improvement at 6 months, continuing to 12 months; **(c)** Visual Reproduction II: improvement for both conditions at 6 months, maintained at 12 months; and **(d)** Logical Memory II: continuing improvement for both conditions. NET = neurocognitive enhancement therapy, WCST = Wisconsin Card Sorting Test, WT = work therapy.

were expected to engage in problem solving and goal setting related to issues identified in their systematic work feedback. The verbal nature of the group and the cognitive demands of problem solving may have combined with other features of WT to produce neuropsychological test improvements, whether or not the participant was receiving NET.

Our findings indicate that WT may improve memory but that NET training was necessary to produce additional durable improvements in executive function and working memory. Perhaps memory functioning can benefit from the general cognitive stimulation associated with work, whereas executive functioning and working memory must be targeted more directly through a cognitive remediation program. The computer-based cognitive exercises used in NET focused mostly on elemental cognitive functioning such as attention and short-term memory, and these exercises may have directly affected the working memory outcomes. Although several of the computer-based exercises included problem solving, other elements of the NET intervention may also have affected executive function. The demand of the social information processing group, dichotic listening task, and cognitive feedback from the work site, which were also part of NET and which demand executive function, likely influenced this type of outcome.

The overall pattern of results suggests that certain cognitive skill areas will likely improve only as long as they are specifically practiced. Other cognitive skill areas, once they receive a “push” from cognitive remediation to change initially, may continue to improve under the general stimulation of everyday activity. Moreover, some cognitive abilities may improve from the nonspecific stimulation of WT or other rehabilitation approaches. Although one could argue that the observed pattern of continued improvement in the WT only condition simply reflects a practice effect, we believe this is unlikely, given that the pattern was not general and only found for a few tasks and given that previous research suggests a lack of significant practice effects for these tasks, even at a shorter retest interval of 10 weeks [40].

This study has several limitations. Although no differential attrition was observed based on baseline data, the loss of 20 percent of the sample over the three observations means that some undetected selection bias possibly occurred. While this does not necessarily threaten the between-group findings, time effects may be more vulnerable to the alternative hypothesis that participants excluded because of missing data were those who had been less responsive to WT. This form of differential attrition would be undetectable from baseline data and would favor a positive effect for time. Therefore, added caution is warranted in interpreting the time linear trends.

This study did not control for the amount of productive activity in which participants could engage, except to have a maximum of 20 paid hours a week. However, participants in both conditions were productive for about the same number of hours and received about the same amount of pay over the 6-month intervention. Although NET + WT participants may have had somewhat more time for nonspecific interactions with research staff around the NET procedures (which were mostly computer-based), WT participants could instead engage in up to 5 additional hours of WT and those extra 5 hours of work could, in turn, give them the nonspecific benefits of more time for interactions with coworkers and supervisors. As just mentioned, this study is also limited by not including a no-treatment control or a condition that included only computer-based exercises. Having these groups would have helped us to sort the likely contribution of WT to cognitive outcomes as well as the contribution of the training exercises alone.

Finally, the relationship of specific NET training elements to specific outcomes is speculative, and a much more complex interaction of training and cognitive outcomes is just as possible. The interaction of all elements of NET combined with WT may be what is responsible for these differential outcomes in working memory and executive function. A true synergy may exist between NET exercises that encourage mental activity and WT that allows a natural context for increased mental activity to be exercised, generalized, and reinforced. NET without WT might not have yielded the same results.

CONCLUSIONS

Cognitive remediation in the context of WT may have neuropsychological benefits in executive functioning and working memory that can endure for at least 6 months after the end of training. WT alone may also improve neuropsychological functioning, particularly in verbal and nonverbal memory.

Future studies may follow two paths. The first is comparing various types of cognitive training and determining their unique contributions with neuropsychological improvement in schizophrenia. Types of training can include various computer-based cognitive remediation methods and comparison between computer-based methods and individual instructional approaches. The effects of different doses of training and methods of maximizing motivation and participation also require testing.

The second avenue of investigation can go beyond neuropsychological effects, looking at the clinical, quality of life, and vocational outcomes from cognitive training. If cognitive rehabilitation combined with WT greatly improves these outcome domains, to next explore improvements in neuropsychological pre- and posttestings as a mediating variable to these functional outcomes would be worthwhile. Also important are questions about whether adding cognitive training boosts rehabilitation outcomes from other interventions, such as occupational therapy. In so doing, we will learn the extent to which cognitive training, when combined with other forms of rehabilitation, can influence community functioning.

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