Effectiveness of Attention Training in Schizophrenia

by Alice Medalia, Manuel Aluma, Warren Tryon, and Arnold E. Merriam

Abstract

This study assessed the impact of attention training on information processing in schizophrenia. Fifty-four inpatients with chronic schizophrenia were randomly assigned to two groups after baseline assessment with the Continuous Performance Test (CPT). Patients in the experimental group participated in individual sessions of computerized attention remediation, while patients in the control group participated in individual sessions during which they viewed video documentaries. After 18 sessions, reassessment with the CPT showed that patients in the experimental group had made significantly more improvement than the control group, which made no significant change. Brief Psychiatric Rating Scale assessments before and after the study phase indicated that both groups improved on the total score but the experimental group made significantly more improvement. These results suggest that it is feasible to use practice and behavioral learning to remediate a core attention deficit in chronic schizophrenia.

Key words: Attention, remediation.

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Patients with schizophrenia have been shown to perform poorly on tasks that require vigilance, quick responses, or sustained attention (Nuechterlein and Dawson 1984). These deficits are evident during episodes of active psychosis as well as during periods of remission and are therefore considered to be trait or vulnerability markers of the disease. Attention impairments correlate with maladaptive functioning (Spaulding 1986; Green 1996) and poor response to specific therapies such as skills training (Corrigan et al. 1994).

Given the impact of attention deficits on psychosocial adjustment and cognitive functioning, it seems important to direct treatment efforts toward the rehabilitation of these deficits. However, in contrast to the extensive literature characterizing the nature, severity, and comorbidity of attentional deficits, there has been very little research devoted to the treatment of attention. Largely exploratory in nature, studies to date concur that this is a promising area for systematic research. Rehabilitation techniques that have been reported to have a positive impact on psychiatric status include those that teach the use of self-instruction during task performance (Meichenbaum and Cameron 1973), that use exercises to promote the ability to ignore distracting stimuli (Adams et al. 1982), and that train patients to maintain continuous work performance (Spaulding 1986) and to process information from social interactions (Brenner et al. 1987).

In other successful training programs, patients performed simple tasks like line bisection (Delahunty et al. 1993), simple number or word games (Olbrich and Mussgay 1990), or reaction time and digit span exercises (Magaro et al. 1986; Benedict and Harris 1989). The most extensive study of attention rehabilitation to date (Benedict et al. 1994) found that 15 hours of practice with computer-mediated vigilance tasks improved attention. In this study, the groups were initially matched on d′; however, the improved posttreatment vigilance decrement score of the experimental group was below the pretreatment vigilance decrement score of the control group. This suggests the potential importance of matching groups on additional pretreatment attentional measures.

In contrast to the relative paucity of similar reports in schizophrenia, successful attention remediation has been convincingly reported in the treatment of those recovering from head injury (Ben-Yishay 1981; Ben-Yishay and Diller 1984; Ben-Yishay et al. 1987). Remediation of this sort is widely performed and available in computerized

Reprint requests should be sent to Dr. A. Medalia, Director of Neuropsychology, Dept. of Psychiatry, Klau-2, Montefiore Medical Ctr., 111 East 210 St., Bronx, NY 10467.

modules that provide practice and behavioral conditioning in the various components of attention. After using one such computerized training module, the Orientation Remedial Module (ORM), head-injured patients not only improved on the tasks themselves, but also on related psychometric tests and functional skills (Ben-Yishay et al. 1987).

Given that the attention deficits of schizophrenia are enduring, disruptive, and linked to adaptive functioning and treatment response (Spaulding 1986; Corrigan et al. 1994), attention remediation could potentially be of great value. The efficacy of such interventions is best examined through the use of controlled studies that focus on aspects of attention that are impaired throughout the various phases of the illness (Erickson and Binder 1986; Flesher 1990; Stuve et al. 1991; Granholm 1992; Green 1993).

We have examined the feasibility of remediating attention in schizophrenia using the ORM, a program developed for head-injured patients (Ben-Yishay et al. 1987). The ORM emphasizes practice in a behavioral learning format that shapes and reinforces attentive behavior through engaging computerized exercises. We measured treatment outcome by change in both psychiatric status and in performance on the Continuous Performance Test (CPT; Rosvold et al. 1956), a test that is sensitive to attention deficits present before onset, during episodes, and in the remitted state. To control for nonspecific treatment effects, results from patients treated with the ORM were compared with those of patients who did not receive targeted attention training. These control patients viewed documentaries, a similarly engaging activity that demands far less intensive focused information processing.

Method

Subjects. Fifty-four inpatients at Bronx Psychiatric Center, a State hospital in New York City, completed this study. To be recruited for the study, patients had to carry the diagnosis of schizophrenia according to *DSM-III-R* (American Psychiatric Association 1987) criteria and be 20–45 years old. Those with diagnosed brain disease were excluded. Admission to the study required that intelligence, as measured by the Quick Test (Ammons and Ammons 1962), fell at least within the borderline to low-average range (cutoff = 70) and that attention, as measured by the CPT, was impaired. We required the latter because we assumed the beneficial effects of remediation would be most apparent in patients with compromised attention. Patients had to obtain a CPT absolute percent correct score below 98.97, which is one standard deviation (SD) below the mean for normal subjects (mean = 99.41; SD = 0.44) (Wang Neuropsychological Laboratory 1988). In fact, all patients obtained scores more than 2 SDs below the mean, that is, below the second percentile for normals.

Every 6 weeks a new group of subjects entered the training phase of the study. Subjects were assigned to the experimental or control group according to their CPT absolute percent correct ranking. Individuals with like rankings were paired in blocks of two and each was then randomly assigned to the experimental or control group. There were 27 patients in each group. Six of the 60 patients originally recruited dropped out of the study because of psychotic decompensation.

Demographics of the two groups are shown in table 1. The groups did not significantly differ in age, education, or IQ. Fifty-two percent of the patients in the experimental group and 59 percent of patients in the control group had a diagnosis of schizophrenia—paranoid type; 37 percent of the experimental group and 41 percent of the control group had a diagnosis of schizophrenia—undifferentiated type; and 11 percent of the experimental group was diagnosed with schizophrenia—disorganized type. All subjects had been in the hospital at least 6 weeks before study participation, and all were being treated with neuroleptics before and during the study. Dose and choice of neuroleptic were selected and titrated on an individual clinical basis by the treating psychiatrists, who were blind to the research hypotheses and study design.

Procedure

After signing informed consent, subjects participated in a videotaped interview with one investigator (MA) to establish that *DSM-III-R* criteria for schizophrenia were met. Patients were then administered the Quick Test and a

Table 1. Demographic characteristics of 54 patients with chronic schizophrenia

	Experimental group (n = 27)	Control group (n = 27)
Age, mean years (SD)	33 (7.5)	32 (5.5)
Education, mean years (SD)	10.9 (2.1)	10.7 (2.1)
Sex, %		
Male	74	81
Female	26	19
IQ, mean (SD)	93 (11.1)	90.9 (8.1)

Note.—IQ was derived from the Quick Test (Ammons and Ammons 1962).

computerized version of the CPT. This CPT version required the subject to press the space bar whenever the target letter "A" appeared on the screen. There were 200 target letters embedded in a series of 600 letters presented randomly, one at a time for 0.83 seconds, in a 10-minute presentation. Interdisplay time was 0.17 seconds.

All subjects with CPT and Quick Test score requirements then met individually with the same clinician for three 20-minute sessions per week for a period of 6 weeks. All sessions took place in a quiet, otherwise unoccupied room on the hospital grounds. The activity during these sessions varied depending on group status.

Subjects in the experimental group spent the first session learning to use the IBM-compatible computer that delivered and scored the ORM. Subsequent training sessions followed a uniform pattern: The first few minutes of each session were spent taking a visual reaction time test from the ORM. The subsequent 15 minutes were spent working on various ORM attention training modules. Each session ended with another visual reaction time test. The clinician was present during all sessions and guided the subject through the test–training–retest phases with feedback like, "Good. Now let's do this," and with necessary explanations of the task.

All subjects in the control group viewed the same preselected National Geographic documentaries in the same order. The clinician sat with patients to view these films in the same room used by the experimental group. While subjects were expected to watch the videos, they were not required to talk about the films or otherwise indicate that they were actively processing them. The clinician did not initiate conversation, but responded briefly to dialog initiated by the subject.

After the 6-week intervention phase was over, all subjects in the experiment again participated in a videotaped interview and were retested on the CPT. Both the initial and postintervention interviews followed the general structure recommended by the authors of the Brief Psychiatric Rating Scale (BPRS; Overall and Gorham 1962) and were videotaped. An outside consultant who was blind to group status, a psychologist trained in rating videotaped psychiatric interviews with the BPRS, viewed each taped interview and provided a BPRS rating.

Attention Training Exercises. The ORM, a computer program developed to remediate attention, was used as the treatment condition of this study. The ORM contains five modules (attention reaction conditioner, zeroing accuracy conditioner, visual discrimination conditioner, time estimates, and rhythm synchrony conditioner) that involve receiving auditory and visual stimuli and eliciting a series of simple visual-motor responses. Progression through one module builds skills thought necessary for subsequent modules. In each module there is a test–train–test sequence, with the test measuring reaction time. The tasks promote arousal, alertness, rapid and well-modulated responsiveness, scanning, target detection, and rapid information processing. The tasks are engaging and patients are given simple, direct feedback about their performance. For example, in the attention reaction conditioner module, the computer screen depicts a pyramid of nine large feedback circles with a smaller target circle centered at the bottom of the screen. The subject must press a key when the target circle turns red; the faster the response, the more feedback circles light up.

Data Analyses. Since the data from the BPRS and CPT outcome measures were not normally distributed, nonparametric statistics were used. Wilcoxon rank sums tests established if there were significant pretreatment differences between groups on the BPRS total score and the three CPT outcome measures (number of right letter detections, number of wrong letter detections, absolute percent correct [number of correct letters detected/total number of targets]).

Wilcoxon signed (Sgn) rank tests were performed on the BPRS and CPT change scores (posttreatment–pretreatment scores) to evaluate changes over time within each group.

Wilcoxon rank sums tests compared the two groups on the amount of change made after 18 sessions. There were two primary CPT outcome measures in these multiple endpoint analyses: number of right letter detections and number of wrong letter detections. The other CPT outcome measure was considered secondary as it was a derivative of the primary measures.

An analysis of variance for repeated measures was done to determine if the visual reaction time scores from the beginning of each session decreased significantly over the course of the 18 ORM treatments provided to the experimental group.

Results

CPT. There were no significant group differences in performance on the three CPT measures at the start of the study. As table 2 indicates, the control group did not show significant change after 6 weeks on any of the CPT measures. By contrast, scores changed significantly in the experimental group for the number of right letter detections (Sgn Rank = 100, $p < 0.0009$) and the number of wrong letter detections (Sgn Rank = –97.5, $p < 0.01$), and hence for the absolute percent correct (Sgn Rank = 75.5, $p < 0.003$). The experimental group improved signifi-

Table 2. Pretreatment and posttreatment CPT and BPRS scores

	Experimental		Control	
	Pre	Post	Pre	Post
CPT right letter detection	167.6 (35.4)	173.6 (30.4)	166.1 (40.1)	167.0[1](37.7)
CPT wrong letter detection	23.2 (20)	16.0 (16.9)	27.7 (21.7)	25.1[2](21.7)
CPT absolute percent correct	83.6 (17.8)	86.5 (15.3)	82.9 (20.1)	83.3[1](18.9)
BPRS total score	30.0 (4.2)	27.2 (4)	29.7 (4.6)	28.1[1](3.6)

Note.—Scores are expressed as mean (standard deviation). CPT = Continuous Performance Test (Rosvold et al. 1956); BPRS = Brief Psychiatric Rating Scale (Overall and Gorham 1962)

[1]Pre to post change greater in experimental group, $p < 0.05$.
[2]Pre to post change greater in experimental group, $p < 0.01$.

cantly more than the control group on the primary CPT measures (number of right letter detections: $Z = 2.02$, $p < 0.04$; number of wrong letter detections: $Z = -2.34$, $p < 0.01$) and the secondary CPT measure (absolute percent correct: $Z = 2.15$, $p < 0.03$).

BPRS. The baseline BPRS total scores did not significantly differ between groups. Both groups showed significant change over time on the BPRS total score (experimental group: Sgn Rank = –142.5, $p < 0.0001$; control group: Sgn Rank = –74.5, $p < 0.03$). The experimental group improved significantly more than the control group on the BPRS total score ($Z = -2.04$, $p < 0.04$). The experimental group showed the most improvement on the following three BPRS subscales: somatization (Sgn Rank = –14, $p < 0.01$), emotional withdrawal (Sgn Rank = –31.5, $p < 0.02$), and hallucinatory behavior (Sgn rank = –28, $p < 0.009$). In view of the risk of Type 1 error in these multiple outcome analyses (18 subscales), p values > 0.002 indicate a trend toward significant change. The control group did not show significant improvement on any of the 18 BPRS subscales.

Reaction Time. In the experimental group, reaction time scores were measured at the start and end of each session. Scores declined significantly over the 18 treatment sessions ($f = 5.28$, $df = 1{,}484$, $p < 0.02$) and the decline in scores at the end of the sessions approached significance ($f = 3.51$, $df = 1{,}484$, $p < 0.06$). The actual decline was modest. The average of pre- and postsession reaction-time scores was 409 milliseconds in session 1 and 361 milliseconds in session 18.

Discussion

This study demonstrated the feasibility of using practice and behavioral learning to remediate a core attentional deficit in schizophrenia. The sample used was representative of an inner-city chronic schizophrenia population. We found that individuals receiving attention training made improvements on the reaction time and CPT measures. Visual reaction time, which was practiced and tested every treatment session, showed a modest improvement. The CPT was not practiced in sessions, yet ability to detect CPT targets improved after treatment. This change in CPT performance indicates that attention training helped patients become more vigilant and less distractible and suggests the generalizability of therapeutic effect.

The effects of attention training further generalized to yield an improvement in psychiatric status. Both groups improved on the BPRS over the 6-week study period, the hoped for result given the context of intensive inpatient psychiatric treatment. However, the group exposed to attention training made significantly more improvement than the control group. Somatization, emotional withdrawal, and hallucinatory behavior were the BPRS subscales that changed most in the experimental group. While it is possible that some uncontrolled variables, such as responsiveness to medication, may account for the greater clinical improvement in the experimental group, we believe this to be unlikely. Patients had been on medications for at least 6 weeks before entering the study, and groups were comparable both on the types of medications and on the BPRS measures of symptomatology from the outset. It would be highly unusual, although not impossible, for the two groups of randomly assigned patients to have differed in their responsiveness to medication.

Other uncontrolled variables, such as treatment parameters outside the study protocol, were comparable for the two groups. Patients participated in similar ward activities and recreational and verbal therapies. Thus, we have every reason to believe that uncontrolled variables related to patients' routine psychiatric treatment had a minimal role in the experimental group's greater BPRS improvement.

Neuroleptics have been reported to improve CPT performance in schizophrenia (Orzack and Kornetsky 1966;

Orzack et al. 1967; Spohn et al. 1977; Medalia and Gold 1992). However, the control group in this study did not improve on CPT measures, which suggests the limited effectiveness of neuroleptic treatment on this parameter. At the outset of this study, all patients had been taking medications for at least 6 weeks, thus they may have already achieved maximum attention benefit from neuroleptic treatment. Focused attention remediation may be useful in improving attention beyond what might be expected from neuroleptic treatment alone.

The possible mechanisms by which ORM training improved attention deserve discussion. The ORM provides practice for the attention functions measured by the CPT (target detection, rapid information processing) while shaping attentive behavior through reinforcement and feedback. There also may be nonspecific therapeutic effects. For example, it could be the computer interaction experience per se, and not the content of the experience, that facilitated improvement in the experimental group. Our control group did not have a computer interactive task to address this issue; however, data from a study that did control for this (Medalia et al. 1994) suggests computer exposure per se is not a significant variable. One nonspecific benefit we did observe was an alteration in social status and self-esteem. Subjects often boasted to ward staff and fellow patients, who were blind to the research hypotheses and study design, about their accomplishments on the training task, which in turn led them to be viewed more positively. Increased confidence and self-esteem may have facilitated improvement in CPT performance and psychiatric status. Comments from our subjects led us to believe that key elements to the success of the program were its focused, consumer-friendly, engaging, and socially valued activities.

Our positive results support and extend the findings of previous, more exploratory studies, but they differ from Benedict et al. (1994), who conducted a controlled trial of computerized attention remediation in outpatients with schizophrenia. That study measured treatment effects by performance on a degraded stimulus version of CPT and used remediation programs similar to the ORM. Our studies therefore differed in the exact attention training program employed in patient population (inpatient vs. outpatient), in sample size, and in the processing demands of the CPT versions used. Furthermore, our study had the benefit of using groups matched on pretreatment CPT performance. Benedict et al. (1994) indicated that poorly matched samples may have obscured the improvement made by their treatment group.

Is our study then an argument for providing cognitive rehabilitation for patients with schizophrenia? The most important clinical question when determining a rehabilitation program's value is whether its effects generalize to other needed functions or at least facilitate the process of rehabilitating other areas of functioning. Future research might address whether modest but significant changes on tests of attention, such as we found, are paralleled by changes on such clinically significant variables as ability to sustain focus on vocational tasks. Cognitive deficits like distractibility and impaired vigilance are thought to interfere with adaptive behavior and to hamper the acquisition of new information and skills (Liberman et al. 1982; Spaulding 1986; Delahunty et al. 1993). Therefore, if it is indeed possible to rehabilitate attention in schizophrenia, it becomes highly important to learn the best techniques and schedules for doing so, the appropriate population to be targeted, and the range of outcomes to be expected. It is possible that schizophrenia, like traumatic brain injury, will take its place among the neuropsychiatric disorders that use systematic cognitive rehabilitation as a cardinal aspect of treatment.

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The Authors

Alice Medalia, Ph.D., is Associate Professor of Clinical Psychiatry and Neurology; Manual Aluma, Ph.D., is Instructor, Department of Family Medicine; and Arnold E. Merriam, M.D., is Professor of Psychiatry and Neurology, Albert Einstein College of Medicine, Montefiore Medical Center, Bronx, New York. Warren Tryon is Professor, Department of Psychology, Fordham University, Bronx, New York.