The Remediation of Problem-Solving Skills in Schizophrenia

by Alice Medalia, Nadine Revheim, and Matthew Casey

Abstract

Efforts to remediate the problem-solving deficits of patients with schizophrenia have met with circumscribed success. This could be viewed as a sign of the immutability of the deficit or, alternatively, as a reflection of the inefficacy of the training techniques used. This study examined the feasibility of using problemsolving teaching techniques developed within educational psychology for remediating the problem-solving deficits of inpatients with schizophrenia spectrum disorders. These techniques rely on intrinsic motivation and task engagement, which are promoted through contextualization, personalization, and control of learning activities. A sample of 54 patients who demonstrated problem-solving and memory deficits on psychometric testing were randomly assigned to a problem-solving group, a memory training group, or a control group. Patients who received ten sessions of problem-solving remediation showed significantly more improvement on the outcome measure that assessed problem-solving skills required for independent living. Patients who received ten sessions of memory training did not improve on problem-solving measures. These results suggest that patients with schizophrenia spectrum disorders are responsive to problem-solving training techniques that promote intrinsic motivation and task engagement.

Keywords: Schizophrenia, cognitive remediation, problem solving, executive functioning


Many patients with schizophrenia are impaired not only by positive and negative symptoms, but also by persistent and severe deficits in cognition (Gold and Harvey 1993; Green 1998). Cognitive impairments have been demonstrated most frequently in the neuropsychological assessment of attention, memory, and executive functioning (Calev 1984; Gold et al. 1992; Braff 1993). These deficits commonly persist after effective psychotropic treatment of psychotic symptoms (Medalia and Gold 1992) and have been demonstrated to interfere with many aspects of successful psychiatric rehabilitation (Kato et al. 1995; Green 1996; Penn et al. 1998). Because of the significant impact on functional outcome for many schizophrenia patients, effective remediation of cognitive deficits has been increasingly recognized as an important component of comprehensive treatment (Storzbach and Corrigan 1996; Kern and Green 1998; Silverstein et al. 1998a).

Studies specifically investigating executive functioning in schizophrenia have primarily used the Wisconsin Card Sorting Test (WCST, Heaton 1981) to measure deficits in concept formation, reasoning, self-monitoring, working memory, and cognitive flexibility. Cognitive problem-solving abilities such as these (as assessed by the WCST, the Wechsler Adult Intelligence Scale [WAIS] comprehension test, or equivalent measures) have been shown to be related to current level of social skill (Penn et al. 1995; Silverstein et al. 1998b), successful skill acquisition during psychosocial rehabilitation (Lysaker et al. 1995b), functional inpatient behavior (Penn et al. 1996), successful outpatient community functioning (Jaeger and Douglas 1992), length of time until rehospitalization (Lysaker et al. 1996), and work performance (Lysaker et al. 1995a; Bellack et al. 1999). Although existing social problem-solving research has not demonstrated significant correlations between WCST performance and general measures of social problem solving (Corrigan and Toomey 1995), the ability to adaptively sequence social schemata has been significantly correlated with the WCST (Corrigan et al. 1992).

With the recognition that cognitive problem-solving ability may act as a rate-limiting factor in successful psychiatric rehabilitation, investigators have recently devoted significant efforts toward remediating this cognitive deficit (Bellack et al. 1990; Summerfelt et al. 1991; Goldman et al. 1992; Green et al. 1992; Metz et al. 1994;
Kern et al. 1996; Stratta et al. 1997). The WCST has been used as both the remediation exercise and the outcome measure in many of these studies. While there is evidence that WCST performance can itself be successfully modified, generalizability of training to other, externally valid measures of cognitive problem solving has not yet been demonstrated (Bellack et al. 1996).

One possible explanation for why problem-solving remediation using the WCST has met with circumscribed success is that the WCST is not an effective remediation tool. Other problem-solving remediation strategies may prove more successful in producing generalizability of training effects. If we turn to the field of educational psychology, it is evident that there is considerable research on effective strategies for teaching problem solving within primary and secondary school curricula. It has been demonstrated that techniques that are able to increase intrinsic motivation, depth of engagement in the learning task, and self-perceived competence result in higher levels of learning and achievement (Lieber and Semmel 1985; Hannafin and Peck 1988; Lepper and Hodell 1989; Kinzie et al. 1992; Bitter et al. 1993). Intrinsic motivation, which occurs when performance of a task is in and of itself rewarding, has been shown to facilitate learning more effectively than extrinsic motivation, which occurs when a reward (e.g., money) is given for task completion (Terrell and Rendulic 1996). Intrinsic motivation, depth of engagement in a task, and self-perceived competence are promoted by the contextualization of learning activities in real-world or fantasy settings, by multisensory presentation of material, and by allowing students to personalize and control nonessential aspects of the learning environment (Cordova and Lepper 1996). Optimization of motivation and depth of task engagement may be especially important with chronic psychiatric patients, who often suffer from apathy, avolition, and poor motivation as core aspects of their illness.

Educational psychology research has informed the development of some educational software programs on CD-ROM. These programs promote intrinsic motivation and task engagement through contextualization, multisensory presentation, personalization, and control. Several such programs are designed to challenge and improve effective concept formation, reasoning, sequencing, self-monitoring, working memory, and cognitive flexibility. These programs are typically contextualized as crime-solving mysteries or as historical journeys requiring organization and problem-solving skills. Most programs allow different levels of difficulty and may automatically increase difficulty level as a student successfully progresses through a series of tasks. Personalized feedback and positive reinforcement are consistently presented. For a more complete discussion of the rationale for incorporating computer-based training in cognitive rehabilitation programs, please see Medalia and Revheim (1999a).

We hypothesized that the problem-solving teaching techniques used in educational settings would also prove to be effective with schizophrenia patients. To this end, we embarked on an exploratory study of the feasibility of using one of the educational software programs described above to remediate problem solving in a schizophrenia sample. With the intent of determining the specific effects of this problem-solving remediation approach, as distinct from any general effects produced by time spent doing other cognitive tasks on a computer, patients were randomly assigned not only to a problem-solving group and a nontreatment control group, but also to a group that participated in computer-based remediation of memory deficits. In order to determine the generalizability of changes in problem-solving ability, patients were assessed both for improvement within the remediation task itself and for change on other externally valid measures of cognitive problem solving. These measures were chosen to assess aspects of cognitive problem solving that are relevant to independent community and vocational functioning.

Method

Subjects. Fifty-four inpatients at Bronx Psychiatric Center, a large New York State–run facility for severely and persistently mentally ill persons, completed this study as part of a larger study investigating both problem-solving and memory remediation in schizophrenia. A total of 560 charts from 17 different 30-bed wards were reviewed over a 2-year period. The method of sampling used was nonprobabilistic and purposive in nature and was done in two phases. The sampling design for chart review in phase 1 was based on the following inclusion criteria: (a) an Axis I diagnosis of schizophrenia, all subtypes, or of schizoaffective disorder, using DSM–IV criteria (American Psychiatric Association 1994), as specified in the most recent psychiatric assessment found in the medical record and validated by the treating psychiatrist at the time of subject recruitment; and (b) an age between 18 and 55 years old. Subjects were excluded if they were non–English speaking; if they had neurological or medical conditions such as a history of head trauma, seizure disorder, or neuromuscular conditions; if they had behavioral disturbances that required ward restrictions; or if they had a concurrent diagnosis of mental retardation (i.e., documentation of IQ < 70 prior to age 18). The initial chart review of 560 patients identified 141 patients who met all study criteria and were eligible for further screening. This group represented 25 percent of the population of charts reviewed. These potential subjects were then told about the nature of the study and asked to participate in phase 2 screening. A subgroup of 114 patients
(i.e., 81% of those eligible from phase 1 screening) agreed to phase 2 screening, which consisted of psychological testing with the tests described below. Patients needed to score at or below the 16th percentile for normal subjects on the Comprehension test of the Wechsler Adult Intelligence Scale, Revised (WAIS–R–CT, Wechsler 1981) and the Immediate Recall subtest of the Wechsler Memory Scale Logical Memory test (WMS–LM–I, Wechsler 1987) in order to establish that both problem solving and memory, which can indirectly affect problem solving, were initially impaired. Eighty-seven patients completed the testing, and 64 patients met phase 2 screening criteria. Of those eligible for study inclusion, 60 subjects (i.e., 94% of those meeting criteria for phase 2 screening) consented to participate in the study.

Recruitment into the study was continuous. Subjects were randomly assigned into one of three groups: problem-solving remediation, memory remediation, or control. There were 20 patients assigned to each group. Six of the 60 patients enrolled dropped out of the study, two in each respective group, leaving 18 patients per group who completed the study. Reasons for dropping out of the study included withdrawal of consent, decompensation, and discharge.

Demographics for the 60 patients enrolled across the three groups are shown in Table 1. These groups did not significantly differ in age, age of first hospitalization, length of stay for current hospitalization, diagnosis, ethnicity, or socioeconomic status. All patients were being treated with a variety of medications (i.e., typical neuroleptics, atypical neuroleptics, and mood stabilizers) before and during the study. Medication type and dose were independently selected and titrated on an individual basis according to the clinical judgment of the treating ward psychiatrist.

Research Design. The study used a test-retest, treatment-controlled design. Prior to random assignment to either of two treatment groups (problem-solving remediation or memory remediation) or the control group, all patients were pretested on measures of problem solving and memory. Patients in the two treatment groups then received two 25-minute sessions per week for 5 weeks. The treatment control group received the standard care given at the hospital. Posttests for all patients were performed after completion of treatment (i.e., 5–6 weeks after initiation into the study). There were no risks involved in the study.

Procedure. Subjects and hospital staff were informed that the purpose of the study was to see what helps improve “ability to remember, concentrate, and cope with tasks of daily living.” In addition to obtaining signed informed consent, a capacity for consent was obtained from the patient’s psychiatrist as per Institutional Review Board requirements and documented in the chart. An appointment time that lasted approximately 1 hour was set up for testing. Patients were initially administered the WAIS–R–CT, the WMS–LM–I, and the Independent Living Scale, factor-analyzed Problem Solving subscale (ILS–PS). Each test was administered according to the standardized instructions. The set of instruments was counterbalanced such that order effects were controlled. Only those patients who scored at or below the 16th percentile on the WMS–LM–I and WAIS–R–CT on the

Table 1. Demographic characteristics of 54 patients with chronic schizophrenia

<table>
<thead>
<tr>
<th>Demographic variable</th>
<th>Problem-solving group (n = 18)</th>
<th>Memory group (n = 18)</th>
<th>Control group (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs), mean (SD)</td>
<td>36.4 (6.3)</td>
<td>33.6 (7.7)</td>
<td>39.0 (8.0)</td>
</tr>
<tr>
<td>Education (yrs), mean (SD)</td>
<td>11.4 (2.0)</td>
<td>9.4 (1.9)</td>
<td>11.6 (1.8)</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>6</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Working class</td>
<td>7</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Middle class</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>12/6</td>
<td>12/6</td>
<td>8/10</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>14</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Schizoaffective disorder</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>GAF score, mean (SD)</td>
<td>39 (11)</td>
<td>39 (12)</td>
<td>34 (9)</td>
</tr>
<tr>
<td>Length of stay (mos), mean (SD)</td>
<td>30 (48)</td>
<td>37 (68)</td>
<td>32 (43)</td>
</tr>
<tr>
<td>Age at first hospitalization (yrs), mean (SD)</td>
<td>22 (4)</td>
<td>19 (4)</td>
<td>23 (7)</td>
</tr>
<tr>
<td>Antipsychotic medications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atypical</td>
<td>10</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Typical</td>
<td>8</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

Note.—GAF = global assessment of functioning; SD = standard deviation.
pretest were considered for enrollment. Subsequent posttesting on the problem-solving measures was done in accordance with the timetable noted above and independently scored by an investigator who was blind to group assignment. Rater effects were controlled because treatment effects remained unknown until the conclusion of the study for all patients.

After initial testing, those subjects assigned to treatment conditions received either problem-solving or memory remediation using intensive training through a series of computerized exercises explained below. Sessions were scheduled twice weekly for 5 weeks for a total of 10 sessions. Training was provided for all subjects in both conditions by the same investigator (N.R.). All sessions took place in a quiet office on the hospital grounds with the same IBM-compatible personal computer.

**Instruments.** The WAIS-R-CT (Wechsler 1981) is a test of verbal knowledge, judgment, and problem solving. It consists of 16 questions regarding social rules and behaviors. The test takes 10–15 minutes to administer. Reliability coefficients for the WAIS-R-CT according to age group range from 0.77 to 0.90 using a split-half procedure, with a mean of 0.84. Test-retest coefficients are approximately 0.80 across age groups. Performance on the Comprehension Test has been shown to be a good predictor of vocational outcome (Bellack et al. 1999).

The Independent Living Scale is a semistructured interview designed to assess the likelihood of successful independent community living (Loeb 1996). The instrument has been used to estimate the competency of adults diagnosed with psychiatric illness, and the standardization sample included a group of individuals with schizophrenia (Loeb 1996). It has five subscales with items designed to assess functional capacity: Memory/Orientation, Managing Money, Managing Home and Transportation, Health and Safety, and Social Adjustment. Problem Solving (ILS–PS) is derived from items on the five subscales using a principal components analysis. The Problem Solving Factor comprised 33 items from these 5 subscales, with factor loadings ranging from 0.30 to 0.59, that measure aspects of problem solving required for community-dwelling individuals. Further studies of the psychometric properties, including studies of concurrent and construct validity, are described in the manual (Loeb 1996). It takes 20–25 minutes to administer. The ILS–PS has an alpha coefficient of 0.86, and test-retest reliability is 0.90. Interrater reliability for the ILS–PS is 0.98. In one study of 162 individuals with schizophrenia and schizoaffective disorder, the ILS–PS was found to be highly predictive ($p < 0.00001$) of inpatient and outpatient status (Medalia and Revheim 1999a; Revheim 2000).

The WMS–LM (Wechsler 1987) is a brief test of verbal memory and narrative recall. The subtest devoted to immediate recall (LM–I) was used. The patient was read a brief paragraph that tells a story and asked to repeat it back to the examiner. Two stories are read sequentially.

**Treatment Groups**

**Problem-Solving Remediation Group.** Subjects in the problem-solving remediation group worked with a software program called Where in the USA is Carmen Sandiego? (Broderbund Software, Version 2.0). This award-winning educational software, which should not be confused with the numerous television shows, games, and books it has inspired, is used in schools and special education programs to teach deductive reasoning, planning, organization, and—as the title suggests—geography. When we assessed the content validity of this software program for remediation of problem-solving skills in schizophrenia, all 72 of the rehabilitation clinicians who viewed the program indicated that it targets planning, organization, and deductive reasoning.

The purpose of the activity is to solve a simulated criminal case by interpreting information given to identify and track the suspect in order to make an arrest. Subjects enter the program as a "Rookie" and are promoted to higher ranks as they solve increasingly difficult cases. Once "The Chief" hands out and describes a case, the subject (a.k.a. the sleuth) "flies" to the crime scene to interview witnesses. Clues leading to the suspect are compiled so that a warrant can be issued. During each investigation the sleuth travels from state to state, interviewing witnesses in order to track the suspect's activity and create an accurate composite sketch of the suspect. The program is highly interactive, and "The Chief" provides feedback.

The examiner also helped train the subjects to perform the sequential procedures and guided them in the problem-solving process (see Medalia and Revheim 1999a for more information about examiner interactions). Structured questions such as "What are your choices and options?" "What are the clues and evidence?" and "What would you do differently?" were meant to facilitate efficient problem-solving strategies using self-monitoring guidelines. Each 25-minute session was completely devoted to working on the task. Some subjects completed one case in the 25-minute session; for others, their work was saved and they resumed the case at the next session. Verbal encouragement and praise were offered to subjects as they mastered procedures in order to perform the task.

**Memory Remediation Group.** Subjects in the memory remediation group worked on a collection of activities found in Memory Package (Sunburst Software), a software program primarily sold to schools and brain injury
rehabilitation programs that was developed by the Rochester, Minnesota, School District to increase memory skills and develop strategies for remembering. The product was awarded the Best Software of the Year award by Technology and Learning (1985) because of its ability to effectively teach memory skills. Five activities were selected from the package for subjects to work on: word pair recollection, visual and auditory sequence recall, picture recall, picture recognition, and list learning. The subjects were taught mnemonic techniques (e.g., acronyms or pairing the spoken word with a visual cue) during execution of these tasks. Verbal praise and encouragement were offered to subjects as they mastered procedures and completed tasks.

**Control Group.** All subjects in the control group participated in routine unit activities (e.g., arts and crafts, medication groups) or centralized services (e.g., work-for-pay program, leisure time) according to their unit privileges and did not receive computer remediation activities for the study period. The investigator did, however, have occasional and brief contact with control subjects on the unit when escorting peers to treatment or reminding them of appointed times for posttesting.

**Results**

**Demographics.** Subjects in the two treatment groups and control group were compared on demographic variables. Descriptive statistics for these variables are presented in table 1. The three groups were equivalent on age, socioeconomic status, gender, diagnosis, age of first hospitalization, type of neuroleptic administered, and use of anticholinergics. A one-way analysis of variance (ANOVA) found a significant between-group difference ($F_{2,53} = 7.23, p < 0.002$) on educational level. Post hoc comparisons found that the mean educational level for the memory group was significantly lower than the mean for both the control group ($p < 0.004$) and the problem-solving group ($p < 0.007$). The problem-solving group did not significantly differ in educational level from the control group.

**Problem-Solving Remediation Task Analysis**

**Progress.** Progress in the software exercise *Where in the USA is Carmen Sandiego?* was measured by the number of promotions to a higher detective rank the subject earned. "The Chief" gives out promotions based on the software’s preset formula, which considers both the number and difficulty of cases solved correctly. All subjects participating in the problem-solving remediation group received at least two promotions, and some were promoted three times.

**Effects on intrinsic motivation.** Shortly after the study began, a poststudy reaction questionnaire was implemented to assess enjoyment, satisfaction, and desire to continue problem-solving remediation activities. The questionnaire was administered to 13 of the 18 problem-solving remediation group subjects. Analysis of this data suggests that subjects enjoyed the activities (mean response of 9.6 on a 10-point Likert scale), were satisfied with their participation (mean response of 8.6 on a 10-point Likert scale), and desired to continue if possible (mean response of 9.6 on a 10-point Likert scale).

**Problem-Solving Outcome Measures.** Table 2 presents mean pretest and posttest problem-solving raw scores for the three patient groups. There were no significant group differences on pretest scores for either the ILS–PS or the WAIS–R–CT. Paired-sample $t$ tests found a highly significant change from pretest to posttest on the ILS–PS for the problem-solving group ($t_{17} = 3.74, p < 0.002$) but no significant changes for the memory or control groups. For the WAIS–R–CT, there were significant changes from pretest to posttest for the problem-solving group ($t_{17} = 2.68, p < 0.02$) and the control group ($t_{17} = 2.46, p < 0.03$), but not for the memory group.

ANOVAs on change scores were conducted to evaluate between-group effects of treatment. For ILS–PS change scores, a highly significant between-group difference was found ($F_{2,53} = 5.18, p < 0.009$). Post hoc comparisons using the Tukey HSD correction of alpha levels found significant differences between the problem-solving group and both the control group (Tukey corrected $p < 0.05$).

<table>
<thead>
<tr>
<th>Table 2. Pretest and posttest raw scores for problem-solving measures</th>
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<tbody>
<tr>
<td><strong>Variable</strong></td>
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<tr>
<td></td>
</tr>
<tr>
<td>ILS–PS</td>
</tr>
<tr>
<td>WAIS–R–CT</td>
</tr>
</tbody>
</table>

Note.—ILS–PS = Independent Living Scale, Problem Solving subscale; WAIS–R–CT = Wechsler Adult Intelligence Scale–Revised, Comprehension test.

1 Pretest to posttest change greater in problem solving group, $p < 0.05$. 
0.05) and the memory group (Tukey corrected p < 0.01). There was no significant difference for ILS–PS change scores between the memory and control groups. Group differences on the ILS–PS change scores remained significant when an analysis of covariance (ANCOVA) with education as the covariate was conducted (F(2, 53) = 3.74, p < 0.03). Group differences on the ILS–PS change scores remained significant when an ANCOVA with neuroleptic and anticholinergic medication as the covariate was conducted (F(2, 53) = 5.34, p < 0.008). For WAIS–R–CT change scores, ANOVA and ANCOVA using education as a covariate failed to find significant between-group differences.

Discussion

This exploratory study looked at the feasibility of using an educational software program as a tool to remediate cognitive problem-solving deficits in schizophrenia patients. The inpatient sample used was representative of an inner-city chronic schizophrenia population. Patients assigned to a problem-solving remediation group not only successfully progressed through increasingly difficult problem-solving remediation tasks, but also demonstrated significant improvement at completion of treatment on an externally valid measure of cognitive problem solving. Previous problem-solving remediation studies using the WCST as a remediation tool have not successfully demonstrated the generalization of improvements on remediation tasks to other measures of problem solving (Bellack et al. 1996).

One explanation for why previous studies have failed to produce generalizability of improvements in problem-solving ability is that the WCST may be an ineffective general remediation tool. Our results suggest the benefit of remediation that incorporates proven educational learning principles and teaches generic problem-solving strategies. Computer-based remediation tasks for the current study were designed to meet these criteria. Educational software was used to teach generic problem-solving strategies and to present cognitive tasks that challenged planning skills, organization, and deductive reasoning. Intrinsic motivation and task engagement were promoted through contextualization, patient control of nonessential aspects of the learning environment, multisensory presentation of tasks, inherently entertaining and fun exercises, and personalization of learning material. We believe that incorporation of these learning principles was valuable in producing generalizability of gains in problem-solving ability and that use of intrinsically motivating remediation activities is particularly important when working with a motivationally compromised population such as schizophrenia patients.

While our remediation approach did result in generalizability of gains to an externally valid measure of problem-solving ability, this result did not extend to both measures of problem solving included in the study. Significant improvement on the ILS–PS was demonstrated; however, post hoc group comparison of improvements on a second general measure of cognitive problem-solving ability, the WAIS–R–CT, was not significant. One explanation for this result is that the ILS–PS more directly measures the cognitive problem-solving capacities targeted by our remediation.

Although ILS–PS and WAIS–R–CT scores were significantly correlated in this patient sample (r(53) = 0.40, p < 0.01), the constructs measured by these scales are notably different. The WAIS–R–CT has previously been shown to be significantly correlated both with a verbal IQ factor (Cohen 1957) and with general social knowledge (Sipps et al. 1987). While some items included in the WAIS–R–CT do assess conceptual reasoning and problem solving, other items are better characterized as measures of verbal abstraction or of long-term memory for general facts. Although the ILS–PS does also assume some basic knowledge of general facts, it is more directly a measure of reasoning and problem-solving ability within the context of situations relevant to independent living. For this reason, the ILS–PS is more likely to reflect generalization of gains in those problem-solving abilities that were targeted by our remediation approach—fluid concept formation, reasoning, planning, organization, and cognitive flexibility.

In addition, because the ILS–PS is significantly correlated with functional measures of successful community living (Loeb 1996; Revheim 2000), generalization of problem-solving gains reflected in this measure is a useful indicator of the potentially beneficial effect of problem-solving remediation on functional outcome. The extent to which successful problem-solving remediation results in improved functional outcome is an important clinical question. Prior research demonstrating the relationship between WCST performance and areas of functional outcome such as work performance, adaptive inpatient behavior, community functioning, time until rehospitalization, and social skill suggests that effective problem-solving remediation may be an important component of comprehensive psychiatric rehabilitation. Replication and extension of our results with other externally valid measures of cognitive problem solving and with measures of functional outcome will be important. Future research might prospectively study the effect of problem-solving remediation on important areas of functional outcome.

In this study, the problem-solving remediation group had a significantly higher educational level than the memory remediation group, which raises the issue of the potential role of educational level in benefiting from
remediation. We cannot definitively state that the specificity of our problem-solving training is not partially mediated by educational level; however, statistical analyses that covaried for education found that group differences in responsiveness to treatment remained. Future research might address this issue by matching subjects on educational level prior to random assignment to treatment and control groups. A further limitation to the generalizability of the results is the use of chronic inpatients as subjects. Additional research extending our findings to less refractory patients would be valuable. Given the relatively modest sample size, replication with larger sample sizes would also improve the reliability of our current findings. Furthermore, it should be appreciated that this study looked at only one problem-solving exercise; there are other activities that can be important for promoting critical thinking, such as groups that discuss problem-solving approaches. The findings presented here must be interpreted within the context of the exploratory nature of the study. Further research on the problem-solving intervention used is necessary; while the face and content validity of the intervention were assessed, the construct validity was not.

To the extent that cognitive problem-solving deficits in chronic schizophrenia patients are remediable, caution must be exercised when interpreting executive functioning impairment as resulting from irreversible prefrontal dementia. Previous neuroimaging studies have suggested that difficulties with WCST performance for a subgroup of patients may be associated with reduced dorsolateral prefrontal activation (Weinberger et al. 1986). With an increasing number of studies demonstrating the efficacy of remediating core neurocognitive deficits in schizophrenia (Kern et al. 1996; Wexler et al. 1997; Medalia et al. 1998; O’Carroll et al. 1999), it becomes important to investigate the possible effect of successful remediation on frontostriatal or limbic activation. Initial research has used neuroimaging of normal control subjects to examine changes in cortical activation associated with procedural learning (Grafton et al. 1992) and with WCST training (Berman et al. 1995). Future cognitive remediation research with schizophrenia patients might investigate this issue by including functional neuroimaging data along with neuropsychological assessment and externally valid functional outcome measures. An additional intent of this study was to demonstrate the treatment specificity of our approach by comparing problem-solving gains made by patients participating in problem-solving remediation with any potential gains made by patients in a computer-based memory remediation group. At termination of treatment, only the problem-solving group demonstrated a significant improvement on the ILS–PS. Neither the control group (which received no instructional exercise) nor the memory remediation group (which was matched on amount of computerized instructional exercise) showed improvements on problem-solving measures. These results indicate that any nonspecific treatment effects of either computer-based activity (as received by the memory group) or general psychiatric treatment (as received by the control group) were not responsible for gains made by the problem-solving group; instead, the specific problem-solving remediation technique used resulted in the significant improvement demonstrated. While general computer-based activity in and of itself may have some remedial effect on certain neurocognitive capacities, such as visual scanning or reaction time, our results suggest that effective problem-solving remediation requires incorporation of specific learning principles and remediation techniques as essential components of the computer-based remediation. Prior research has also suggested that computer activity alone does not result in effective remediation of problem-solving capacity (Medalia and Revheim 1999a), and some reports indicate that computer-based methods are not even necessary to effect improvement, as long as generic problem-solving strategies are taught (Brenner et al. 1992; Wykes et al. 1999) and the treatment is individualized (Spaulding et al. 1999). A challenge for future cognitive remediation research is to enhance the clinical impact and generalizability of computer- and non–computer-based remediation by finding optimal approaches with which to incorporate effective teaching techniques and learning principles.

References


Remediation of Problem-Solving Skills


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The Authors

Alice Medalia, Ph.D., is Associate Professor of Clinical Psychiatry and Neurology, Albert Einstein College of Medicine; Nadine Revheim, Ph.D., is a Research Psychologist at Nathan Klein Institute for Psychiatric Research; Matthew Casey, Ph.D., is a Psychologist at Albert Einstein College of Medicine, Bronx, NY.