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Symptoms Versus Neurocognition as Predictors of Change in Life Skills in Schizophrenia after Outpatient Rehabilitation

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Abstract

A growing body of literature has shown that neurocognitive deficits in schizophrenia account for 20–60% of the variance in measures of outcome, and in many studies, are more closely related to outcome than symptoms (Green et al., 2000; 2004). Most of these studies have been cross-sectional, few longitudinal studies have investigated the degree to which neurocognition and symptoms predict ability to benefit from outpatient rehabilitation, and no longitudinal studies use measures of everyday life-skills that are performance-based. In the current study we investigated the relationship between five measures of neurocognitive function, crystallized verbal ability, visual sustained vigilance, verbal learning, problem-solving, and processing speed, and two measures of symptoms, total positive and negative symptoms, and change on a performance-based measure of everyday life-skills after a year of outpatient rehabilitation. Rehabilitation consisted of both psychosocial and cognitive interventions. Forty-six patients with schizophrenia or schizoaffective disorder were studied. Results of a linear regression model revealed that verbal learning predicted a significant amount of the variance in change in performance-based measures of everyday life skills after outpatient rehabilitation, even when variance for all other variables in the model was accounted for. Measures of crystallized verbal ability, sustained visual vigilance, problem-solving, processing speed and symptoms were not linked to functional status change. These findings emphasize the importance of verbal learning for benefiting from psychosocial and cognitive rehabilitation interventions, and suggest the development of alternative rehabilitation strategies for those who do not benefit.

1. Introduction

Schizophrenia is a chronic and profoundly disabling psychiatric disorder. Diagnosis is predicated on a marked decline in social and occupational or educational functioning, and current estimates suggest that 85% of patients are unemployed at any one time, and only 1% of patients with schizophrenia who receive Social Security Disability Insurance (SSI/SSDI) ever remove themselves from entitlements. With prevalence rates in North America ranging from ½ to 1%, the estimated cost of the illness to society, in terms of lost wages and lifelong

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medical care is on the order of billions of dollars (Rupp & Keith, 1993; Salkever et al., 2007).

Over the past twenty years, a wealth of evidence has shown that patients with schizophrenia show 1–2 standard deviation impairments on a variety of measures of neurocognitive function, including attention, episodic and working memory, language, and problem-solving relative to healthy matched controls (see Heinrichs & Zakzanis, 1998 for a review). These deficits are present at disease onset (e.g., Saykin et al., 1994), stable over time (e.g., Gold et al., 1999; Hoff et al., 1999; Kurtz et al., 2005; Stirling et al., 2003), and are only modestly affected by pharmacologic intervention for symptoms (e.g., Harvey & Keefe, 2001; Keefe et al., 2007).

Particular significance has been attached to these deficits, as there are a growing number of studies showing that deficits in elementary neurocognitive function are linked to a variety of aspects of functional outcome cross-sectionally and in some cases longitudinally as well. Reviews suggest that neurocognitive deficits explain 20–60% of the variance in studies of the ability to solve interpersonal problems, community (social and occupational) function and measures of skill acquisition in rehabilitation programs (see Green et al., 2000; Green et al., 2004 for reviews). Many of these studies also suggest that neurocognitive deficits are more closely linked to functional outcome than are psychiatric symptoms (e.g., Green et al., 2000).

There have been, however, several exceptions to these findings. For example, Norman et al., (1999) in a study of 50 patients with schizophrenia entering a community case management and family support program, found that measures of episodic memory, executive-function and verbal fluency measured at study entry were not linked to outcome at a 1-year follow-up. Similarly, Addington and Addington (2000), in a sample of 65 patients receiving routine community care failed to find relationships between neurocognitive measures of verbal IQ, early information processing, attention, memory, organization and executive-function measured at study entry and clinician-rated community function and quality-of-life at a 2.5-year follow-up.

Understanding the links between neurocognitive function and everyday life-skills has assumed greater importance with rapidly increasing efforts to develop new pharmacologic agents (e.g., the National Institute of Mental Health Measurement and Treatment Research to Improve Cognition in Schizophrenia [NIMH-MATRICS]) and novel behavioral interventions (see McGurk et al., 2007, for a review) targeted directly at these deficits. These interventions are predicated on the assumption that changes in fundamental neurocognitive skill, along with appropriate learning experiences, will improve life skills in patients with schizophrenia. One crucial line of evidence for this assumption is that neurocognitive deficits are predictive of functional status. While such a correlational link does not ensure that improvement in neurocognitive function will translate into improvements in everyday life skills, it seems unlikely that improved neurocognitive function will have an impact on life skills in the absence of such a relationship.

Several limitations in the extant literature relating neurocognitive and symptom variables and outcome can be identified. First, most studies of symptom and neurocognitive prediction of functional outcome have relied on clinician-rated measures of community (social, educational and/or occupational) function. The ability of patients to demonstrate these community skills, even if they are capable of doing so, is highly dependent on factors largely unrelated to the aberrant neural activity thought to underlie the neurocognitive deficits and phenomenology characteristic of the disease. Employment opportunities and support services in the patient's particular locale are likely to have a large impact on job activity, while community recreational opportunities, access to relevant peer groups and financial resources will likely affect measured social-skill and activity. Thus, important relationships between neurocognitive and symptom factors and functional status may be overlooked secondary to variance introduced by these uncontrolled factors. Second, with some exceptions (e.g., Brekke et al., 2005, 2007; Kern et al., 1992; Mueser et al., 1991; Smith et al., 2002; Woonings et al., 2002), the vast majority of studies in this area have typically investigated neurocognitive and symptom predictors of outcome after limited community treatment consisting of case management and medication management during the follow-up interval. For studies that have specifically investigated predictors of response to cognitive rehabilitation programs, these studies have utilized outcome measures closely linked to the intervention rather than more general measures of everyday life activities (Fiszdon et al., 2005). Thus, the neurocognitive and symptom predictors of everyday-life-activity after cognitive and psychosocial rehabilitation remain unclear. Third, only a limited number of studies have investigated the utility of neurocognitive and symptom predictors of *change* in functional outcome measures over a follow-up period (Addington & Addington, 2000; Brekke et al., 2005, 2007; Friedman et al., 2002; Mueser et al., 1991; Smith et al., 2002 Woonings et al., 2002). This is important as studies of functional change suggest which neurocognitive and symptom features may predict improvement as a result of a specific intervention beyond those features linked to functional status cross-sectionally.

The current study was designed to investigate the degree to which crystallized verbal ability, visual vigilance, verbal learning and memory, problem-solving and processing speed, measured at entry to a rehabilitation program, would be linked to change in functional status as measured by a laboratory-administered, functional capacity measure that assessed key tasks relevant to everyday life-skills after outpatient rehabilitation. All neurocognitive measures selected for the current have been linked to functional outcome in the extant literature. The degree to which positive and negative symptoms related to change in functional status was also evaluated.

We selected a measure of functional capacity, the UCSD performance-based skills assessment (UPSA; Patterson et al., 2001), as an index of functional status. Several studies have supported the ecological validity of this laboratory-administered functional capacity measure in patients with a primary psychotic disorder, showing that UPSA performance is related to caretaker measures of physical functioning, personal care skills, interpersonal skills, social acceptability, community activity and work skills (Bowie et al., 2006), as well as residential independence (Mausbach et al., 2007; Twamley et al., 2002). Furthermore, research indicates that the UPSA is a better predictor of residential independence than gross measures of cognitive status or symptoms (Mausbach et al., 2007). We predicted that all measures of neurocognitive function would be linked to change in functional capacity, as measured by the UPSA, following community rehabilitation treatment, while there would be little relationship between symptoms and changes in functional capacity.

2. Methods

All study procedures met with institutional ethical approval. Patients who agreed to take part in the study gave written, informed consent at the time of their entry to outpatient rehabilitation and were randomly assigned to one of two computerized cognitive rehabilitation groups (cognitive remediation or computer-skills training). The results comparing the relative effects of these interventions on neuropsychological test performance in a subset of the patients described in this paper were previously reported (Kurtz et al., 2007). In the present paper we describe results collapsed across computer interventions. The computer therapies were provided in addition to other day-program community rehabilitation activities.

2.1 Participants

Forty-six outpatients meeting DSM-IV (APA, 1994) criteria for schizophrenia or schizoaffective disorder as determined by the Structured Clinical Interview for DSM-IV (First et al., 1995) participated. Exclusion criteria for patients included auditory or visual impairment, evidence of mental retardation as indicated by a history of services evident from the medical record, traumatic brain injury with loss of consciousness for more than an hour, presence or history of any neurologic illness, lack of proficiency in English, and/or criteria met for concurrent substance abuse or dependence. Recruitment for the study was continuous, over a period of six years (2001–2007) and occurred at three sites. The majority of patients in the study (n=39) were recruited from and enrolled in an intensive outpatient program for patients with schizophrenia at The Institute of Living (IOL) in Hartford, CT and two smaller cohorts were recruited from social clubs at community mental health centers in Meriden, CT (n=5) and East Hartford, CT (n=2). Clients were assessed at the termination of the computer interventions, a mean 12.4 months (SD: 4.8) after study entry. Patients treated at The IOL were enrolled in a three-day per week program including structured group therapy, life-skills training, and exercise, Life-skills training consisted of individualized goal-setting based on client and treatment team agreement for improving community function, steps for achieving stated goals and an analysis of whether goals were achieved. Goals included increasing social interaction for clients who desired more social contact, or strategies for increasing medication adherence for clients who were at risk for relapse. Clients at the other two community mental health sites typically attended social clubs on a daily basis, but participated in a more limited set of group activities (e.g., daily food preparation). Twenty-three additional patients who completed the entry assessment but failed to complete a minimum of 15 hours of computer training were not assessed a second time and their data was removed from the study. There were no significant differences on neurocognitive measures selected for the current study between the completers and non-completers (all ts $\leq$ 1.62, all ps $\geq$.11). Demographic and clinical characteristics of the sample of completers are presented in Table 1.

2.2 Neurocognitive Measures

Patients were assessed before cognitive and psychosocial rehabilitation on a neuropsychological test battery. To reduce elevation of Type I error in the current study, measures of visual vigilance, verbal memory, problem-solving and processing speed were selected as these specific measures have been commonly linked to simulated, performance-based social functioning, as well as actual community and vocational status in patients with schizophrenia (e.g., Dickinson et al., 2007; Green et al., 2004; Gold et al., 2002; McGurk & Meltzer, 2000). As recent studies have highlighted links between crystallized verbal skills and performance-based measures of social and daily life skills (e.g., Dickinson et al., 2007), and to ensure that specific relationships between neurocognitive skills and change in functional capacity in the current study could not be explained by differences in estimated verbal intellectual function, we included crystallized verbal skills as an additional cognitive domain. Neurocognitive testing and scoring was supervised by a doctoral-level psychologist.

2.2.1 Vocabulary subtest from the WAIS-III Wechsler, 1997)—An oral measure of word knowledge that is thought to provide an estimate of crystallized verbal ability. Individual items on this subtest were scored on a 0–2 basis and the total score across 33 items was used as an independent measure.

***2.2.2 Penn Continuous Performance Test* (PCPT; Rosvold et al., 1956; Kurtz et al, 2001)—**A visual vigilance task that required the participant to respond as quickly as possible whenever a set of lines formed a number. Correct responses are indicative of visual vigilance, while false positive responses are considered indicative of impulsivity. Speed of information processing is measured by reaction time to targets. A measure of efficiency was calculated as an independent variable by dividing true positive responses by average reaction time.

2.2.3 California Verbal Learning Test-II (CVLT-II; Delis et al., 2000)—This is a list learning task in which 16 words from 4 semantic categories are read to the subject over a series of 5 list presentations. This test measures verbal learning, verbal memory and semantic organization. The learning slope across 5 trials was selected as the independent measure as it reflects the average number of new words per trial that an examinee is able to recall, and thus provides a direct index of the ability of the participant to benefit from repetition of verbal information.

2.2.4 Penn Conditional Exclusion Test (PCET; Kurtz et al., 2004a, 2004b)—The PCET is a measure of problem-solving. Results from several studies have shown strong evidence of construct validity in samples of healthy people (Kurtz et al., 2004a) and patients with schizophrenia (Kurtz et al., 2004b) for this task. The PCET requires the participant to select out one of four items based on one of three sorting principles. Participants must infer the sorting rule based on feedback to their responses. When the participant gets 10 consecutive correct responses, the sorting principle shifts and there are a total of three sorting principles. Total errors were selected as an independent measure.

2.2.5 Processing Speed Index from the Wechsler Adult Intelligence Scale-III (PSI; Wechsler, 1997)—The PSI consists of the Digit Symbol-Coding and Symbol Search subtests of the Wechsler Adult Intelligence Scale-III (WAIS-III) and provides an index of processing speed. The Digit Symbol-Coding subtest requires the participant to draw symbols under paired numbers during a 120-second time limit, using a key at the top of the test page. The number of correctly drawn symbols during the time limit was measured as the dependent measure. The Symbol Search subtest requires the participant to visually scan groups of symbols for the presence or absence of target symbols within a 120-second time limit. The number of items correctly scanned within the time limit was recorded as the independent measure in this task.

2.3. Symptom Measures

The Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) was used to assess symptoms at entry to the study. This measure is a semi-structured interview that generates ratings of signs and symptoms on 30 7-point Likert scale items. Symptom raters for the study maintained interrater reliability through periodic rater training sessions, and all raters were trained to a criterion reliability of.8 intraclass correlation coefficient (ICC), across four jointly viewed, but independently rated interviews. The subscales for total positive and total negative symptoms were selected as the independent measures.

2. 4 UCSD Performance-Based Skills Assessment (UPSA; Patterson et al., 2001)

This standardized, performance-based instrument of everyday function provides information regarding patients’ ability to plan trips to the beach and zoo (recreation planning), count out and provide change using actual domestic currency and write checks for bills (finance), ask for information and reschedule a doctor’s appointment via the telephone (communication), plan a bus trip on the local bus system using relevant maps (mobility), and identify items necessary for a recipe that are missing from a simulated pantry (household management). Each of the five subscales was scored on a 1–20 scale, thus summing subtest scores results in a total score on a scale of 0 to 100.

2.5 Data Analysis

Only participants with complete data on study variables from the entry and follow-up assessments were included in the analysis. Data were evaluated for normality. In no case was there evidence that variables included in the study violated the assumptions underlying the use of parametric statistical procedures. We investigated relationships between neurocognitive and symptom measures at study entry to change in functional status during the interventions in two steps. In the first step we computed Pearson bivariate correlation coefficients between measures of positive and negative symptoms and crystallized verbal ability (Vocabulary subtest of the WAIS-III), sustained visual vigilance (PCPT efficiency), verbal learning (learning slope from the CVLT-II), problem-solving (PCET errors) and processing speed (PSI from the WAIS-III) at study entry and change in performance-based functional status (UPSA) from study entry to the termination of the computer interventions.

In a second step, we conducted a multiple regression analysis including these same variables, and also controlled for group membership (cognitive remediation or computer-skills training) by entering this variable into the regression equation as well. All variables were entered in a single-step. By including baseline measures of performance-based functional status in the regression equation, variance attributable to this measure was removed from post-treatment measures of performance-based functional status. In this way, all observed relationships between neurocognitive and symptom variables in the regression could be attributed to *change* in performance-based functional status across the 1-year rehabilitation treatment trial. To evaluate the relative role of symptoms versus neurocognition in predicting change in performance-based functional status across the rehabilitation trial, we conducted a second multiple regression using a hierarchical block entry procedure in which baseline performance-based functional status scores and group membership was entered in a first block, symptom measures in a second block, and neurocognitive variables in a third block. To facilitate understanding of results, those variables in which higher scores indicated poorer performance or a greater number of symptoms were multiplied by −1. Alpha was set at.05 and all statistical tests were two-tailed.

3. Results

Moderate gains on total UPSA scores from pre-to post-rehabilitation training were evident with considerable heterogeneity in individual response. As can be seen in Table 2, Pearson bivariate correlations showed that of the neuropsychological measures, only the learning slope from the CVLT-II at study entry was associated with change in total scores (r=.32), Recreation (r=.45) and Finance (r=.32) subtest from the UPSA from study entry to follow-up. Of the symptom measures, only total positive symptoms at study entry were associated with change in Transportation subtest scores from the UPSA.

The results of multiple linear regression investigating the relationship of neurocognitive and symptom measures with change on the UPSA are presented in Table 3. The model, which partitions mutually exclusive components of the overall variance for each variable, explained 46% of the variance in total UPSA scores at the end of the treatment trial (R^2=.46, F[9,36] =3.43; p<.005). Higher baseline total scores on the UPSA (t=2.18; p<.05) and higher learning slope on the CVLT-II (t=2.48; p<.05) independently predicted UPSA scores after treatment. Lastly, the results of block entry of baseline functional status score and group membership (block 1), symptoms (block 2), and neurocognitive measures (block 3) are presented in Table 4. Here again is evidence of the association between learning on the CVLT-II prior to treatment and improvements in post-intervention functional status scores (R^2=.19), even when baseline functioning measures, group membership and symptoms were controlled. Again, symptoms did not explain a significant amount of variance beyond that accounted for by baseline functioning scores and group membership.

4. Discussion

This is among the first studies to investigate the relative role of neurocognition and symptoms on change in functional status during outpatient cognitive and psychosocial rehabilitation in schizophrenia, using a performance-based measure of instrumental-life skills. These results demonstrate in a longitudinal design that neurocognitive skills predicted change in functional status after a one-year course of cognitive and psychosocial rehabilitation in patients even when variance attributable to symptoms, baseline life-skill scores and type of computerized cognitive rehabilitation (cognitive-remediation versus pre-vocational computer-skills training) was controlled. More specifically, analysis of individual neurocognitive measures showed that verbal learning predicted change in functional status after the rehabilitation trial even when other neurocognitive and symptom variables were accounted for. Measures of positive and negative symptoms, crystallized verbal ability, sustained visual vigilance, problem-solving and processing speed were not related to change in functional status after outpatient rehabilitation. These findings are particularly salient in that they do not simply suggests a link between neurocognitive skill and functional status, but instead suggest which cognitive skills are most predictive of the ability of patients with schizophrenia to capitalize on community-based intensive cognitive and social rehabilitation programs. As described in the Introduction, the findings from the current study also are important as they provide a window onto predictors of change in ability to conduct basic life tasks without the confounding factors of social and employment support and opportunity in a patient’s particular home locale at a particular point in time that are inherent in interview-based measures of psychosocial function.

It is important to note that a growing number of studies have indicated global, rather than specific, relationships between a broad range of neurocognitive measures and performance-based measures of social skill (e.g., Dickinson et al., 2007) and measures of vocational and community function (e.g., Gold et al., 2002). One study highly related to the current findings (Twamley et al., 2002) showed that performance in seven separate neurocognitive domains, derived from a comprehensive neuropsychological test battery, was linked to UPSA performance with highest correlations between verbal ability and total UPSA values. In the current study, only verbal learning, however, was linked to change in performance-based functioning scores across the 1-year trial with other cognitive and symptom measures controlled. This discrepancy suggests that the neurocognitive factors mediating longitudinal, treatment-related change in functional capacity may be more selective than cross-sectional relationships between neurocognitive factors and performance-based functional status.

The obtained findings are consistent with some published reports, but not others. For example, Smith et al., (2002), investigated the relationship of symptoms, as measured by the SAPS and SANS, and measures of selective attention and verbal learning and memory on a clinician-rated scale of social activities (The Social Behavioral Schedule) in 46 patients with schizophrenia. Results revealed a link between measures of verbal learning and memory, as well as divided attention and symptoms of disorganization, and outcome after a year of intensive rehabilitation. This study also reported a relationship between negative symptoms and clinician-rated functional status that the authors noted may have reflected method variance. The absence of such a link in the current study may reflect the lack of such shared method variance between measures of negative symptoms and the performance-based measures of everyday living-skill selected for the current study. More recently, Brekke et al., (2007) in a sample of over 100 patients with schizophrenia, has shown strong links between neurocognitive and social-cognitive measures and rehabilitative change, as measured by a clinician-rated scale of work, social functioning, and the ability to live independently after, a 1-year period of intensive, community-based rehabilitation. Similar links between neurocognition and outcome have also been reported for changes in vocational status in community-based supported employment rehabilitation programs (McGurk et al., 2003)

In contrast, Woonings et al., (2002) reported non-significant relationship between verbal learning at entry to an 8-month rehabilitation program including cognitive and psychosocial strategies and a clinician-rated scale of social interaction. Differences in findings between studies may reflect their use of a total acquisition score across five trials of a verbal learning measure, rather than a slope-value based on rate of acquisition, as well as the use of a clinician-rated scale that focused solely on social interaction.

Several caveats to the current findings should be noted. First, the results of this study are of a group that provides guidance on *which* neurocognitive and symptom variables may be linked to change in functional status as a result of rehabilitation, rather than *how* these variables impact functional status (i.e., whether verbal learning has a direct or indirect effect on change in functional status). Larger sample sizes, coupled with the inclusion of additional, potential mediating variables, such as measures of social cognition and self-efficacy, would be necessary to address these questions (see Brekke et al., 2005). Second, the use of learning slope as an index of verbal learning equates participants who may show very different overall performance on the measure of learning selected for the study (e.g., a participant that goes from 1 to 5 words recalled across 5 learning trials would look similar to one that went from 11 to 15 items recalled). Nonetheless these findings emphasize that it is the ability to benefit from verbal repetition, rather than overall test performance, which predicts change in functional capacity as a result of rehabilitation. Third, it is important to note that the results of the current study revealed a greater role of neurocognition than symptoms in predicting change in functional status in a specific treatment program that included computer and life-skills training, that by their nature place high demands on cognitive skill. The relationship of symptoms and neurocognition to change in functional status over time may be different in other settings. Fourth, the current sample size of 46 participants is modest for a multiple regression analysis, and important relationships between study variables and changes in performance-based functioning as a result of rehabilitation may have been overlooked as a consequence. Lastly, measures of performance-based everyday life skills have been criticized for serving as simply more ecologically-valid measures of neurocognitive skill, and thus links between neurocognitive skill and these measures may represent an artifact of method variance. Nonetheless, we note that while performance-based measures of everyday life skills undoubtedly require a host of neurocognitive skills, including sustained attention, memory and problem-solving, we have documented a selective relationship between only one aspect of neurocognition, verbal learning, and the relationship is not with absolute level of everyday life skills but rather in change in everyday life skills over the course of a specific treatment.

In summary, these results emphasize the importance of verbal learning as a predictor of acquisition of everyday life-skills for patients with schizophrenia enrolled in outpatient psychosocial and cognitive rehabilitation. These findings suggest that new rehabilitation strategies, tailored to be either minimally dependent upon repetition and acquisition of verbal information, or implementing compensatory strategies that circumvent these deficits, such as overlearning of verbal information, may help those patients showing less benefit from these types of currently offered psychosocial and cognitive rehabilitation strategies. Novel behavioral and pharmacologic interventions targeted at improving verbal learning may also allow patients to take better advantage of existing rehabilitation interventions

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Table 1

Mean demographic and clinical characteristics of schizophrenia patients (n=46).

Variable	Mean (SD)	Range
Age	34.6 (10.0)	19–53
Percent male	72	
Education	13.4 (1.9)	10–18
Duration of Illness (years)	9.6 (8.2)	1–33
Age of onset (years):	25.6 (7.2)	14–42
Number of hospitalizations	3.9 (2.7).	0–13
Vocabulary Scaled Score (WAIS-III)	10.5 (3.5)	1–18
Number of training hours	60.4 (25.8)	22–106
Percent treated with atypical antipsychotic medication	100	

Note: WAIS-III=Wechsler Adult Intelligence Scale.

Table 2

Pearson correlations between baseline performance-based functioning, symptoms, neurocognitive skills at study entry and change in performance-based functioning (total and subtests) from study entry to termination of the computerized interventions (n=46).

Variable (Mean +/SD)		**Total**		**Recreation**		**Finance**		**Transport**		**Commun**		**House**	
		r	**p**	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**
Positive Symptoms PANSS	18.4 (5.1)	.07	.647	−.05	.744	.00	.981	.29	.048	−.05	.727	.05	.759
Negative Symptoms PANSS	20.3 (4.8)	.01	.932	−.02	.906	−.14	.352	−.02	.899	.16	.288	−.03	.831
Vocabulary (WAIS-III)	10.5 (3.5)	.04	.774	−.04	.794	.09	.535	.22	.142	.00	.985	.06	.697
CPT-Efficiency	.07 (.01)	−.12	.417	−.07	.627	.11	.455	.08	.616	−.23	.127	−.07	.668
Learning Slope (CVLT-II)	1.2 (0.7)	.32	.031	.45	.002	.32	.031	.06	.680	.12	.421	.04	.819
PCET errors	50.5 (29.8)	.02	.894	.08	.604	−.27	.068	.17	.272	.08	−.050	−.03	.820
Processing Speed Index (WAIS-III)	82.4 (11.0)	−.06	.676	.06	.674	.01	.936	.20	.187	−.14	.358	−.12	.412

Note: UPSA=UCSD Performance-Based Skills Assessment; PANSS=Positive and Negative Syndrome Scale; WAIS-III=Wechsler Adult Intelligence Scale; CPT=Continuous Performance Test; CVLT-II=California Verbal Learning Test-II; PCET=Penn Conditional Exclusion Test; Comm=Communication subtest from the UPSA; House=Household Management subtest from the UPSA

* =p<.05;

** =p<.005.

Table 3

Results of multiple regression predicting UPSA total score at termination of a 12-month computer training trial.

Variable	Beta	t-value	p-value
Baseline UPSA	.32	2.18	.036
Group	−.05	−.35	.727
Positive Symptoms (PANSS)	−.01	−.05	.960
Negative Symptoms (PANSS)	.19	1.42	.165
Vocabulary (WAIS-III)	.21	1.36	.183
Penn CPT Efficiency	−.13	−.94	.352
CVLT-II Learning Slope	.34	2.48	.018
PCET Errors	.09	.66	.516
Processing Speed Index (WAIS-III)	.06	.40	.694

Note: UPSA=UCSD Performance-Based Skills Assessment (UPSA); PANSS=Positive and Negative Syndrome Scale; WAIS-III=Wechsler Adult Intelligence Scale; CPT=Continuous Performance Test; CVLT-II= California Verbal Learning Test; PCET= Penn Conditional Exclusion Test.

Table 4

Results of block entry linear regression predicting UPSA total score at termination of a 12-month computer training trial.

Variable	Beta	t-value	p-value
Block 1[a]			
Baseline UPSA	.50	3.75	.001
Group	−.04	−.23	.784
Block 2[b]			
Positive Symptoms (PANSS)	−.02	−.14	.886
Negative Symptoms (PANSS)	.16	1.15	..256
Block 3[c]			
Vocabulary (WAIS-III)	.21	1.36	.183
Penn CPT Efficiency	−.13	−.943	.352
CVLT-II Learning Slope	.34	2.48	.018
PCET Errors	.09	.66	.516
Processing Speed Index (WAIS-III)	−.06	.40	.694

[a] R^2=.2 5, F=7.14, df=2,43, p=.002

[b] Non-significant.

[c] R^2=.19, F=2.52, df=5,36, p=.047

Note: UPSA=UCSD Performance-Based Skills Assessment (UPSA); PANSS=Positive and Negative Syndrome Scale; WAIS-III=Wechsler Adult Intelligence Scale; CPT=Continuous Performance Test; CVLT-II= California Verbal Learning Test; PCET= Penn Conditional Exclusion Test.