Attentional Characteristics of Schizophrenia Patients Differing in Learning Proficiency on the Wisconsin Card Sorting Test

by Karl H. Wiedl, Joachim Wienöbst, Henning H. Schöttke, Michael F. Green, and Keith H. Nuechterlein

Abstract

The Wisconsin Card Sorting Test (WCST), a test of concept formation, was given to 49 schizophrenia inpatients in three blocks of 64 cards each with the second block comprising special instructions and trial-by-trial feedback. With the help of a psychometric algorithm based on linear regression analysis, the patients were classified according to their response to these specific interventions. Results yielded 15 high scorers, 23 learners, and 11 nonlearners. This a priori classification was confirmed by cluster analysis. Next, these groups were further analyzed with the Degraded Stimulus Continuous Performance Test (DS-CPT), a test of target discrimination, and the Test of Attentional Style (TAS), which assesses habitual, subjectively experienced attentional problems. A significant difference between high scorers and nonlearners was found for discriminative sensitivity (d'), with the learners achieving intermediate scores. Results for only the DS-CPT response criterion (β) and a TAS subscale (Distractibility) tended to be significant. Discriminant analysis also revealed that d' is the most powerful variable for discriminating among the subgroups. The article also addresses baseline versus dynamic assessment, specific rehabilitation needs in subgroups of schizophrenia patients different in learner status, and the neurocognitive characteristics of the subgroups.

Keywords: Cognitive modifiability, subclassification of schizophrenia patients, dynamic assessment.


Cognitive remediation research has shown that schizophrenia patients can be taught to improve their concept formation, as measured by the WCST (Heaton 1981; Green et al. 1992; Kern et al. 1996). This finding is particularly important, because impairments in this domain are considered key schizophrenia deficits. Various questions remain unanswered, however, including how these impairments relate to everyday functioning and whether training of concept formation generalizes to broader domains of behavior; also, there seem to be substantial interindividual differences among schizophrenia patients in ability to learn this task (Goldberg and Weinberger 1994; Green et al. 1997). This article discusses interindividual differences. Results from earlier studies have suggested that schizophrenia patients can be separated into learners and nonlearners (Green et al. 1990) with regard to WCST performance. An alternative grouping has been as follows: good (continuously high performance), poor (nonlearners), and remediable (learners; Stratta et al. 1994). The usefulness of classifying patients according to learner status is the focus of this article. Our main question, which was stimulated by the Dynamic Testing Approach (Wiedl et al. 1995; Guthke and Wiedl 1996), is whether classification of patients according to changes in test performance can be related to constructs such as learning ability, cognitive modifiability, and rehabilitation potential. To answer these questions, one needs to show that these subgroups are not merely the result of random variation but instead reflect systematic differences in learning, and that the subgroups contribute to diagnosis, prognosis, and treatment planning (Wiedl and Schöttke 1995).

As a first step, a psychometric algorithm for the a priori classification of patients according to learner status and to control for random effects was developed (Schöttke et al. 1993). The advantage of this a priori approach in classification is that it does not require specific statistical information on the whole sample but can be applied to a single case. Different from common clinical procedures of classifying performance, the algorithm is based on a psychometric theory of mental tests. (A more detailed description of the algorithm is given in the

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Method section of this article.) The algorithm was applied in studies in which the WCST was given with special instructions and continuous trial-by-trial feedback during the second presentation within a test-retest design (Guthke and Wiedl 1996; Wiedl and Wienöbst 1999; Wiedl et al. 1999, 2001). Depending on the specific samples, 17 percent to 25 percent of the patients proved to be nonlearners, 22 percent to 33 percent high scorers, and around 50 percent learners. Based on a larger sample, this a priori classification was empirically confirmed with the help of cluster analysis (Wiedl et al. 1999), yielding fairly good correspondence between clusters and a priori defined subgroups (kappa = 0.78).

Subsequent validation research showed that the groups defined by learner status differed in their total number of weeks of hospitalization since first admission (high scorers < learners < nonlearners). Furthermore, when patients in three treatment settings varying in level of rehabilitative training demands were assessed, the distribution of learner status across settings corresponded significantly to the intensity of attempted psychiatric rehabilitation (nonlearners < learners, high scorers). This suggests that clinical decisions about the level of rehabilitation to be expected from patients were related to this WCST assessment of ability to learn concept formation. There was also a tendency for nonlearners to be higher in negative symptoms (Wiedl and Wienöbst 1999). In a study with the German version of the Auditory Verbal Learning Test (Heubrock 1992), subjects were given special instructions and feedback after the second and third presentations of the stimuli. We found that WCST learners improved their recall performance immediately after the verbal feedback and thus caught up with the high scorers, whereas nonlearners tended to remain at the same level of performance (Wiedl et al. 1999, 2001). Learners and nonlearners thus seem to differ in their ability to profit from verbal interventions. In another pilot study (Wiedl and Wienöbst 1999), schizophrenia patients were given brief training with the cognitive differentiation component of Brenner et al.'s Integrated Psychological Therapy program (1994). The extent of improvement with training was found to be predicted by learner status and level of education. Also, for a subsample of the patients of the study presented here (Wiedl 1999; Carlson and Wiedl 2000), it was shown that learner status is related to proficiency in a clinical training on problem solving and medication management, which was developed according to the principles applied in the Medication Management Module Device (Wallace et al. 1992).

Taken together, these studies suggest that schizophrenia patients can be meaningfully classified according to their ability to learn concept formation as assessed by the WCST. Furthermore, these subgroups differ on clinical measures, verbal learning, and response to rehabilitation training. The goals of the present study were (1) to replicate the validation of this classification through cluster analysis, and (2) to determine whether the WCST learner groups are distinctive in their attentional functioning. Attentional functioning was selected as a neurocognitive domain of interest because it is believed to be one of the most common and fundamental areas of cognitive deficit in schizophrenia (Nuechterlein and Dawson 1984; Nuechterlein 1991; Braff 1993). Whereas various laboratory tasks have been designed to study attentional performance at the level of experimentally controlled conditions, the subjective experience of attentional deficiencies has been widely neglected. Inclusion of this level seems critical because subjective indicators may reflect basic attentional disturbances and may constitute an important factor in the patients' everyday functioning, including learning in interpersonal situations (van den Bosch et al. 1993). Therefore, both levels of assessment are considered in this study. Furthermore, we selected attentional measures that detect relatively stable traitlike qualities of schizophrenia patients because differences among the learner groups in such enduring characteristics would have implications for both the nature of these groups and the design of different rehabilitative strategies.

The CPT (Rosvold et al. 1956), which assesses target discrimination during vigilance, was used because it has high retest reliability; is free of practice effects (for exceptions, see Nuechterlein 1991); and does not reflect transient behavioral disturbances, variations in positive symptoms, or manipulations of motivation. High-risk and family studies indicate that impaired CPT performance may index an underlying pathological process that constitutes at least one component of vulnerability to schizophrenia (Nuechterlein 1991). A degraded-stimulus version of the test (DS-CPT, Nuechterlein et al. 1983), which places a processing load on early stimulus encoding and feature extraction processes, seems particularly suited for the assessment of a traitlike vulnerability factor, as this test has been shown to be stable within patients across psychotic and clinically remitted states (Nuechterlein et al. 1992). Of particular interest is that this test seems to be related to learning in a skill acquisition program (see Green 1996).

Another test that reliably (for exceptions, see below) measures traitlike aspects of attentional disturbance is the TAS, a questionnaire developed by van den Bosch et al. (1993). In analyses of reliability and stability over an interval of 3 months, van den Bosch et al. (1993) had found retest correlations well above 0.80 for four of the five subscales and stability of group means throughout. The authors thus conclude that the TAS assesses habitual, subjectively experienced attentional problems. TAS scores do not correlate significantly with objective measures of attention such as CPT performance (van den Bosch and
Rombouts 1998). However, two subscales (Distractibility and Overload) have been shown to be related to the mental effort that patients report as required by the CPT. The authors conclude that subjective cognitive dysfunction as measured by subscales of this test may correspond to the degree of effort mobilized in everyday situations. Thus, its scales apparently tap attentional dimensions that are separable from CPT performance and may have relevance for individual differences in learning ability.

**Method**

**Subjects.** The total sample consisted of 49 inpatients of a psychiatric state hospital who met DSM-III-R criteria of schizophrenia or schizoaffective disorder (American Psychiatric Association 1987). Patients were diagnosed by an experienced psychiatrist and a senior research clinical psychologist at a best estimate diagnostic conference using all sources of information available (e.g., the German version of the Structured Clinical Interview for DSM-III-R [Wittchen et al. 1990; for n = 32 patients], clinical records, and indicators of illness course). The latter sources of information were only used in conjunction with a well-established clinical diagnosis of schizophrenia or schizoaffective psychosis given during previous hospital stays. For entry into the study, the patients had to be past their acute episode of psychosis. Subjects were excluded if they had a history of substance or alcohol dependence or an identifiable neurological disorder. After being given full information about the project, patients who consented were administered the assessments described below. All patients were paid $20 for full participation in the study, which included additional testing and training in medication management and problem solving (to be reported on elsewhere). All patients were receiving neuroleptic medication, with a number of subjects (n = 15) receiving atypical neuroleptics. Cross-classification of learner status and atypical versus conventional neuroleptic medication yielded a nonsignificant distribution ($\chi^2 = 0.83$, df = 2). Average IQ was 96.02 (standard deviation [SD] = 14.57) in a measure estimating premorbid intelligence (verbal comprehension; Metzler and Schmidt 1992). Further clinical and demographic information is given in Table 1. It is evident that the sample under study was composed of young patients who were moderately chronic and that the learner groups did not differ in indicators of chronicity.

**Table 1. Means and standard deviations for learners, nonlearners, and high scorers for clinical and demographic variables (n = 49)**

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Post hoc comparison for nonequal variances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Nonlearners</td>
<td>34.9</td>
<td>7.42</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Learners</td>
<td>33.6</td>
<td>8.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>29.5</td>
<td>4.29</td>
<td></td>
</tr>
<tr>
<td>Years of education</td>
<td>Nonlearners</td>
<td>10.18</td>
<td>1.17</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Learners</td>
<td>10.68</td>
<td>1.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>11.27</td>
<td>1.39</td>
<td></td>
</tr>
<tr>
<td>Chlorpromazine equivalents</td>
<td>Nonlearners</td>
<td>408.82</td>
<td>221.93</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Learners</td>
<td>533.52</td>
<td>360.43</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>389.26</td>
<td>212.35</td>
<td></td>
</tr>
<tr>
<td>Number of admissions</td>
<td>Nonlearners</td>
<td>6.22</td>
<td>3.70</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Learners</td>
<td>6.80</td>
<td>6.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>4.00</td>
<td>2.35</td>
<td></td>
</tr>
<tr>
<td>Total length of admissions</td>
<td>Nonlearners</td>
<td>80.08</td>
<td>86.79</td>
<td>NS</td>
</tr>
<tr>
<td>(wks)</td>
<td>Learners</td>
<td>90.49</td>
<td>92.93</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>67.64</td>
<td>67.85</td>
<td></td>
</tr>
<tr>
<td>Illness duration (yrs)</td>
<td>Nonlearners</td>
<td>8.27</td>
<td>5.64</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Learners</td>
<td>8.28</td>
<td>7.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>5.60</td>
<td>4.01</td>
<td></td>
</tr>
<tr>
<td>Intelligence (WST)</td>
<td>Nonlearners</td>
<td>92.30</td>
<td>14.71</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Learners</td>
<td>94.41</td>
<td>12.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>100.87</td>
<td>17.57</td>
<td></td>
</tr>
</tbody>
</table>

*Note.*—NS = nonsignificant; SD = standard deviation; WST = Wortschatztest (test of verbal capacity or word power).
Cognitive Assessments. The WCST (Berg 1948; Heaton 1981) is a test of concept formation in which the subjects are required to match 128 cards to one of 4 target cards. Matching rules are color, shape, or number of symbols on each card. Under standard administration, the subjects are told "right" or "wrong" after each match. After ten consecutive correct matches, the tester changes the rule without informing the subject.

Unlike the standard procedure, in this study the WCST was given in a pretest-training-posttest sequence in one session with each block comprising 64 cards. Pretest (T1) and posttest (T3) were identical with the standard procedures described by Heaton (1981). As in previous studies (Wiedl et al. 1999; Wiedl and Wienöbst 1999; Wiedl et al. 2001); the training block (T2) was administered according to the trial-by-trial intervention procedures described by Green et al. (1992) and Goldberg et al. (1987). These procedures had been shown to consistently increase schizophrenia patients' performance (T2), but without clear evidence of durable effects (T3).

After finishing the first block, patients were informed that they would now get help. Before starting the second block, they were told the three sorting rules (color, form, number). After every card sort, the patients were also told why their choice was right or wrong (e.g., "This was wrong; we aren't sorting for color now, but for form or number"). Subjects were informed of change of category (e.g., "Correct, you had to sort for color. With 10 consecutive correct sorts now completed, the rule will change. You will now no longer sort for color but for form or number"). Between the three blocks, brief breaks of approximately 5 minutes were provided. Altogether, WCST administration took 30–45 minutes. Among the test scores that can be computed, the number of correct responses, the number of categories achieved, and the number of perseverative errors are the most commonly used. For our analysis of interindividual differences, the number of correct responses was selected due to its advantageous distributional characteristics.

The WCST was given to all 49 study subjects in order to have the largest possible sample size for the cluster analysis to further validate the classification system by learner status. Subjects who were available for additional assessment sessions were administered attentional measures relevant to the second goal of the study, determining whether the learner groups differed in attentional characteristics.

The DS-CPT (Nuechterlein et al. 1986) was given using a microcomputer program (Nuechterlein and Asarnow 1996). Subjects were presented a rapid series (one per second) of briefly exposed (33 milliseconds) single digits from 0 to 9 in quasi-random order. The stimuli were degraded by reversing black-white color assignment for a random 40 percent of the pixels. Each subject was presented with the same set of degraded stimuli. Subjects were instructed to press a button whenever a 0 appeared; this occurred for 25 percent of the stimulus presentations. The visual angle of the target stimulus (0) was 3.2 degrees. Eighty trials with undegraded stimuli and 160 trials with degraded stimuli were provided as practice. This was followed by 480 test trials with the degraded stimuli. For analysis, indexes derived from signal detection theory were used. The index 'd' was selected as a measure of discriminative sensitivity and the \( \beta \) index was selected as a measure of response criterion (liberal responses, false alarms).

The TAS was used as a measure of subjective cognitive dysfunction. The TAS is a 31-item self-report questionnaire developed through factor analysis on the basis of the Test of Attentional and Interpersonal Style (van den Bosch et al. 1993). Subscales are Distractibility (e.g., "When people talk to me I find myself distracted by the sights around me"), Overload (e.g., "Sounds come at me so rapidly that they make me dizzy"), Processing Capacity (e.g., "I am good at quickly analyzing complex situations"), Attentional Control (e.g., "It is easy for me to focus my attention on one thing"), and Conceptual Control (e.g., "I need to have all the information before I say or do something"). With the exception of Conceptual Control (\( r_u = 0.65 \)), the subscales have good retest reliability (around \( r_u = 0.85 \)).

Classification of Patients According to Learner Status. The algorithm, which had been developed for single case analysis by Schöttke et al. (1993), is derived from the method of measuring change via residuals of linear regression. Based on the internal consistency and the mean and SD of the test, a hypothetical parallel test score is predicted for every subject's pretest score. Next, the standard error of prediction is calculated and the confidence interval for hypothetical parallel test scores is determined using the \( z \) distribution (for a closer description of the statistical terms, see Lord and Novick 1968). When the subject's empirical posttest score (after intervention) is located outside the confidence interval, "change" is assumed (\( p = 0.05, 2\text{-tailed} \)). To take care of floor or ceiling effects, no decision according to change is made when the lowest or the highest score that can be achieved in this test is located inside the confidence interval.

Because a coefficient of internal consistency cannot be computed for the WCST, retest reliability was used as a substitute (\( r_u = 0.77 \) for correct responses). Using this algorithm, a cutoff of 15 points for correct responses (approximately 1.5 SD) was estimated to reflect significant changes of performance. The following rule was established for classifying the subjects and to control for floor and ceiling effects: Given a maximum of 64 cards per block and the cutoff for significant change selected,
measurable improvement cannot be expected above an initial score (T1) of 43 correct responses. This score was computed by reducing the maximal score (64) by the number of trials necessary to identify the six changes of categories that are possible (6 \times 1) and then subtracting the critical change score (15 points). Patients were thus classified as high scorers when they scored 43 or higher in blocks T1 and T3 (before and after training). Subjects who improved by at least 15 points were classified as learners. The rest of the subjects were nonlearners. A category was also provided for subjects whose performance declined by at least 15 points.

Procedure. All patients were assessed in two sessions on consecutive days. The WCST and the DS-CPT were administered on different days. The WCST was always administered first to maximize sample size for the cluster analysis to validate subgroups. Because the TAS did not require the added step of arranging assessment in a separate laboratory off the inpatient unit, the sample for the TAS (n = 42) was larger than for the DS-CPT (n = 32).

Statistical Analyses. Nonparametric statistics (Friedman Test, Wilcoxon Matched Pairs Signed Ranks Test) were used for the analysis of changes in WCST performance because of heterogeneity of variances (Levene statistics). For an empirical check of a priori groups defined by WCST learning, a method of cluster analysis using euclidean distances (Ward) was selected. Factor analysis with varimax rotation was used for the inspection of the TAS subscale structure. For comparison of WCST subgroups, ANOVAs and discriminant analysis were applied. For group differences close to the conventional level of significance (0.05 < p < 0.10), effect sizes (Hedges g; Hedges and Olkin 1985, p. 81, formula 10) are computed to estimate effects that might be missed because of small sample size (for a discussion of this methodological issue, see Cohen 1994).

Results

Effects of Intervention on WCST Performance and Subject Classification. Across all subjects, correct responses for T1 to T3 were $M_1 = 35.55$ (SD = 12.09), $M_2 = 60.29$ (SD = 2.41), and $M_3 = 48.53$ (SD = 11.83). Results of the Friedman Test and Wilcoxon Matched Pairs Signed Rank Test yielded a significant main effect for testing conditions on number of correct responses ($\chi^2 = 79.14, df = 2, p = 0.0001$) with all pairwise comparisons being significant ($p \leq 0.001$). As in the studies described above, there was a significant increase of performance with intervention (test plus training) and a significant drop at posttest scores. Yet the latter performance is significantly higher than the initial level at first testing (level of significance adjusted for attenuation). Similar results were obtained for the other WCST scores for the three blocks (categories achieved: $M_1 = 1.69$, SD = 1.31; $M_2 = 5.18$, SD = 0.86; $M_3 = 3.29$, SD = 1.79; perseverative errors: $M_1 = 16.96$, SD = 10.6; $M_2 = 0.64$, SD = 1.16; $M_3 = 6.88$, SD = 6.41, all $p \leq 0.001$). All of these scores are unrelated to the indicators of chronicity listed in table 1.

Next, learner types were determined using the algorithm described above. Results showed 15 high scorers, 23 learners, and 11 nonlearners. No subjects with decline of performance were identified. Figure 1 displays the WCST correct responses for each group. Means (SDs) of the groups for T1 to T3 are 33.2 (11.9), 52.2 (2.58), and 31.55 (10.21) for nonlearners; 28.8 (7.58), 60.57 (2.27), and 51.78 (7.21) for learners; and 48.9 (4.13), 61.20 (1.82), and 56.00 (4.49) for high scorers. Post hoc comparisons for nonequal variances (Tamhane; $p < 0.05$) clearly replicate the findings from our previous studies, showing that nonlearners and learners are significantly different from high scorers at T1, whereas at T3, learners and high scorers are different from nonlearners. The same pattern of results is obtained for categories achieved and perseverative errors. Subgroups were not significantly different in the clinical or demographic characteristics that are reported in table 1. Also, they did not differ in severity of symptoms as assessed with the Brief Psychiatric Rating Scale (Ventura et al. 1993, F = 1.80, $p = 0.18$) and the Scale for the...
Test of Attentional Style. \( p < 0.10; \) \( p < 0.05. \)

In order to validate our a priori classification procedure, a cluster analysis was computed using the Ward procedure with quadratic euclidean distances. It resulted in three clusters, which clearly describe high scorers, learners, and nonlearners. Cross-classification of the clusters with the a priori groups yielded a kappa of 0.78, thus proving the high correspondence of the two classifications. Deviations occurred for two nonlearners who were clustered as learners and for five learners who were clustered as nonlearners (three) or high scorers (two).

**Learner Status and Attention.** The subjectively experienced attentional dimensions measured by the TAS subscales were submitted to factor analysis with subsequent varimax rotation because of moderate to high between-scale correlations. Two factors with eigenvalues greater than 1 were extracted, representing 53.4 percent and 28.0 percent of the total variance, respectively. The first factor was marked by Distractibility (loading of 0.92), the second factor by Conceptual Control (0.95). Because Conceptual Control had low reliability (0.65) and did not discriminate healthy subjects and different groups of psychiatric patients (van den Bosch and Rombouts 1998), it was excluded from further analysis. Next, Bravais-Pearson correlations between the DS-CPT scores and Distractibility were computed. No significant relationships were detected at the 0.05 level. However, there was a tendency for learners to feel more distracted than nonlearners or high scorers. Effect sizes are \( g = -0.70 \) (learners vs. nonlearners), \( g = -0.81 \) (learners vs. high scorers), and \( g = 0.07 \) (nonlearners vs. high scorers).

**Prediction of Learner Status.** It appeared from the previous analyses that learners differed in target discrimination and tended to differ in the response criterion and distractibility. In order to explore whether learner status can be predicted by these variables, discriminant analysis was conducted \( (n = 32) \). One discriminant function proved to be significant \( (r = 0.68, \text{Wilks-Lambda} = 0.45, p < 0.003) \) with the standardized canonical coefficients of discrimination being 1.075 (\( d' \)), -0.59 (Distractibility), and 0.51 (\( B \)). Reclassification of subjects yielded a rate of 69 percent correct with 100 percent of hits for nonlearners, 78 percent for high scorers, and 50 percent for learners. Sensitivity on the CPT thus seemed to be the most powerful discriminant variable for learner status.

**Discussion**

The research presented here is the third study demonstrating that subgroups of schizophrenia patients can be established.

### Table 2. Means and standard deviations for learners, nonlearners, and high scorers on various measures of the DS–CPT and TAS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subgroup</th>
<th>Mean</th>
<th>SD</th>
<th>Post hoc comparison for equal variances (LSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discriminative sensitivity (DS–CPT; ( d' ))</td>
<td>Nonlearners</td>
<td>1.85</td>
<td>1.06</td>
<td>Nonlearners &lt; high scorers**</td>
</tr>
<tr>
<td></td>
<td>Learners</td>
<td>3.00</td>
<td>1.21</td>
<td>Nonlearners &lt; learners*</td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>3.54</td>
<td>1.39</td>
<td></td>
</tr>
<tr>
<td>Response criterion</td>
<td>Nonlearners</td>
<td>0.34</td>
<td>1.01</td>
<td>Nonlearners &lt; high scorers*</td>
</tr>
<tr>
<td>(DS–CPT; ( B ))</td>
<td>Learners</td>
<td>1.27</td>
<td>1.16</td>
<td>Nonlearners &lt; learners*</td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>1.55</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>Distractibility (TAS)</td>
<td>Nonlearners</td>
<td>20.22</td>
<td>6.20</td>
<td>Nonlearners &lt; learners*</td>
</tr>
<tr>
<td></td>
<td>Learners</td>
<td>23.80</td>
<td>4.42</td>
<td>Learners &gt; high scorers*</td>
</tr>
<tr>
<td></td>
<td>High scorers</td>
<td>19.83</td>
<td>5.25</td>
<td></td>
</tr>
</tbody>
</table>

*Note:* DS–CPT = Degraded Stimulus Continuous Performance Test; LSD = least squared difference; SD = standard deviation; TAS = Test of Attentional Style.

1 \( n = 42 \) for TAS; \( n = 32 \) for DS–CPT.

\( p < 0.10; \) **\( p < 0.05. \)
lished that differ in responsivity to a specific procedure of cognitive remediation: detailed instructions and trial-by-trial feedback while administering the WCST. Whereas there is a larger group of poor performers at initial testing (two-thirds, learners and nonlearners), some of these poor performers (learners) catch up with the high scorers at posttest. Thus there is significant change of performance for nearly half of the subjects of this study, which, as was shown in this paper and in previous work, is related to meaningful criteria, including the prediction of proficiency in rehabilitation training. It is this information that goes undetected if only measures from standard application of the WCST are used. Comparisons for the various WCST indexes show that the differences between the groups are pervasive, including aspects of concept formation, concept attainment, and perseveration. Whether "learning" takes place among the high scorers also cannot be determined because of the ceiling of the test.

Unlike in previous studies, the learners were not different in number or total length of admissions to the hospital. This indicates that the information provided by the typology of learner status is not necessarily related to severity or chronicity of illness. Nor is it associated with symptoms, education, or premorbid intelligence. Effects of these variables should be visible only in larger samples of subjects.

We hypothesized that there would be a significant effect of learner status on DS--CPT performance. Results from ANOVAs show that target discrimination (d'), more than response style (B), clearly differentiates the groups. Level of concept formation (high scorers) in the WCST and the ability to increase performance by learning thus seem to be related to this very basic aspect of attentional capacity. Also, discriminant analysis underlines the importance of vigilance as a basic component of learner status. This assumption is in line with results that show that DS--CPT performance (d') is correlated with skill acquisition, another domain of learning (see Green 1996). In addition, the fact that other studies have indicated that d' on the DS--CPT is a stable indicator of vulnerability (Nuechterlein et al. 1992) implies that differences in learner status may represent different levels of an important trait. The role of response style (B) is unclear and will require a larger sample to clarify the importance of this variable. Also, for a more refined comparison of the groups, it would be helpful to further differentiate the high scorers with regard to level versus change of performance. Using the WCST, this could not be accomplished because of the ceiling of the test. The group of high scorers may thus comprise patients who have a stable level of high performance, patients who are learners at a high level, or both.

Regarding the ratings on the Distractibility scale, there was a trend for the learners to show higher subjec-
tive attentional strain than the other groups. Keeping in mind that the Distractibility scale probably indicates the degree of mental effort mobilized in everyday situations, we could infer from these results that high scorers who do well in the WCST (and score high in vigilance) usually do not need to mobilize as much energy and thus do not feel habitually distracted. Among those who initially perform poorly on the WCST, there is one group that is aware of their performance, mobilizes energy, and feels a high degree of distraction (the learners). In contrast, another subgroup (the nonlearners) is not aware of these (more pronounced) deficiencies, avoids energy mobilization, and does not experience strong feelings of distractibility. Tests of these hypotheses should be designed to describe subgroup differences with more precision. A model should be conceived and tested that integrates the salient correlates of learner status that are so far suggested by our results: verbal learning and memory, specific attentional capacity, and effort mobilization.

From a clinical perspective, our categorical approach to cognitive remediation points to implications for rehabilitation. Together with the results presented in previous studies, this study indicates that learner groups are different in very basic aspects of neurocognition. The question is whether the different groups will have different rehabilitation needs. Especially for nonlearners, a very narrowly tailored intervention technology may be necessary to achieve possible cognitive remediation. A first step could be the ingenious procedures of training described by Kern et al. (1996), applying principles of errorless learning to teaching the WCST, and by Lam (1997), who developed training based on decomposition of WCST task requirement.

There is increasing evidence of a relationship between neurocognitive performance and success of psychiatric rehabilitation. The current study extends this line of research by assessing one's ability to learn through repeated neurocognitive testing with intervening training (i.e., dynamic assessment). This approach has the advantage of assessing change in performance rather than only baseline performance. Grigorenko and Sternberg (1998), in their recent review of dynamic testing, came to the conclusion that this approach has great "potential to understand people's potentials, but that its potential has yet to be realized fully" (p. 75). We think that the approach described in this study is one step in this direction, contributing to the identification of rehabilitation potential in schizophrenia patients.

References


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