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Effects of Attention Process Training on cognitive functioning of schizophrenic patients

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Abstract

The goal of this study was to investigate the impact of Attention Process Training (APT) on cognitive functioning in schizophrenia. Twenty-four patients with schizophrenia were randomly assigned to one of the two following conditions: training by means of APT or no training. The dependent variables included measures of attention, memory and executive functions derived from a cancellation task, dichotic listening, dual task, Trail Making Test, Paced Auditory Serial Addition Task, Everyday Attention Questionnaire, Spain-Complutense Verbal Learning Test and Wisconsin Card Sorting Test (WCST). All participants were also rated on measures of positive and negative symptoms. The tasks were administrated to all participants at baseline. Participants in the training group received individual intensive APT twice a week, whereas the control group did not receive training. All participants were subsequently retested on the same tests. Although, contrary to expectations, neither group improved on clinical and information-processing measures of attention and memory, patients in the trained group had a significantly higher performance on executive function (as measured by the WCST) than did the control group. We conclude that it is feasible to use practice in attention to remediate executive function deficits in schizophrenia.

Keywords: Cognitive rehabilitation; Information processing; Executive functions; Attention deficits; Cognitive remediation

1. Introduction

Research has consistently revealed that cognitive deficits are a central feature of schizophrenia, and one of the main factors that contribute to its functional and social impairment (Velligan et al., 1996; Bellack et al., 1999). Although schizophrenic patients present deficits across a large number of cognitive domains, vigilance deficits are among the areas where these patients show a poorer and more stable performance (Wykes and van der Gaag, 2001). Attention deficits have been the focus of extensive research because they are one of the main complaints of schizophrenic patients in their daily life and are also markers of vulnerability for the disease (Nuechterlein et al., 1994). The literature is also consistent with the hypothesis that cognitive deficits may be an important determinant both of social-skills functioning

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and the ability to profit from social skill interventions (Massel et al., 1991; Penn et al., 1995; Spaulding et al., 1999; Wykes et al., 1999; Green et al., 2000). Furthermore, adequate attentional functioning may be an important prerequisite for higher cognitive functions (Shallice, 1988; Corrigan and Storzbach, 1993).

Some authors have proposed that cognitive impairment is an important target for intervention, as cognitive disturbances have been found to have more impact on everyday activities than have positive and negative symptoms (Green, 1996). Surprisingly, compared with the impressive body of research on cognitive impairment in schizophrenia, there is relatively little investigation of cognitive rehabilitation in schizophrenia, specifically about attention, in clinical settings (Wykes and van der Gaag, 2001). A review of the literature on the effects of attention and cognitive training on attentional functioning in schizophrenic patients shows that data are still inconclusive and provide no evidence for or against cognitive rehabilitation as an elective treatment for schizophrenia (Hayes and McGrath, 2000, Suslow et al., 2001).

Terms such as 'cognitive rehabilitation' or 'cognitive remediation' refer to the provision of interventions that enhance or redevelop a broad range of thinking or mental processing skills. There are three basic approaches to cognitive rehabilitation (Sohlberg and Mateer, 1989). These approaches can be conceptualized as a functional adaptation approach, a general stimulation approach, and a process-specific approach. The functional adaptation approach minimizes the load on cognitive processing instead of trying to improve cognitive functioning. It is based on the assumption that certain cognitive deficits are best treated by providing external aids that obviate the problem instead of retraining to eliminate the defective process. General stimulation is based on the assumption that cognitive functions can be improved by stimulating the cognitive systems, but this approach does not target specific cognitive functions. The therapy usually includes exercises that require several mental skills. Presumably, by using these skills, people will improve their cognition, and the improvement will transfer to their everyday activities. When there are deficits in specific cognitive areas, treatment should be oriented toward targeted remediation of the deficits, so the last approach should be chosen to work with specific cognitive functions. This approach is similar to stimulation therapy, although it focuses on specific areas of cognition.

There is evidence that patients with schizophrenia can learn new skills in highly structured training settings (Bellack et al., 1999, 2001). A number of studies have examined the process-specific approach in the context of attentional processes, showing that deficits in that function can improve. Benedict and Harris (1989) analyzed the effect of repeated practice with computer-mediated cognitive tasks. Participants who received cognitive training improved their reaction time whereas no improvement was observed in untreated participants.

Two studies have considered the possibility of generalization of training effects to tasks that require similar cognitive operations. Yet, these two studies present different types of stimuli and operate according to different training programs. One of the studies (Benedict et al., 1994) found no significant changes on the outcome measures following treatment despite the fact that the patients showed improved performance on the training tasks. Nevertheless, the other study (Medalia et al., 1998) revealed that practice in a behavioral learning format that shapes and reinforces attentive behavior by means of computerized exercises remedied performance on a simple-letter Continuous Performance Test (CPT) modality.

Unfortunately, as Wykes and van der Gaag (2001) have noted, most of the studies on attention rehabilitation in schizophrenia have used training programs without explicit references to any underlying theoretical model of attentional functioning (Olbrich and Musgay, 1990; Ahmen and Goldman, 1994). Therefore, it is difficult to know why some specific tasks, and not others, are chosen for intervention purposes. As in other areas of rehabilitation (e.g. Taub et al., 2002), interventions on attentional performance should be based on sound theoretical models (Wykes and van der Gaag, 2001). One of the few exceptions in this area is Attention Process Training (APT), an intervention program designed by Sohlberg and Mateer (1989)

to rehabilitate attentional problems in people with head injuries (Park et al., 1999; Sohlberg and Mateer, 1987). The program is based on a model that considers attention as a multidimensional cognitive capacity, and several levels of attention are addressed in the therapy model (focused, sustained, selective, alternating and divided attention). Within the neuropsychological tradition, APT provides an individualized, highly structured intervention.

Another important issue in any intervention program is to choose an appropriate strategy for selecting dependent variables. To better evaluate the impact of cognitive training, tasks should be selected that are sensitive to impairments in remitted schizophrenia patients, such as the CPT, which seems to detect trait-like deficits in those patients, instead of tasks such as reaction times, which are strongly associated with the presence of psychotic symptoms (Nuechterlein and Dawson, 1984). Despite the importance of outcome tasks, it is surprising that most of the studies in this field use few outcome tasks (Brenner et al., 1987; Benedict and Harris, 1989; Olbrich and Musgay, 1990; Benedict et al., 1994; Medalia et al., 1998).

The current study was designed to investigate the impact of APT on attentional processes in schizophrenia. This program was selected because it has shown effectiveness with brain-injured people and because it is organized around a theoretical model of attention. To control for nonspecific treatment variables, a group of patients with schizophrenia who did not receive APT was also included in the design.

Because outcome measures are important, we carefully selected a considerable array of cognitive tasks, in an attempt to include all the attentional levels that would be trained. Thus, we included tests that assess sustained, selective, divided, and alternating attention, with both visual and auditory material. The design included tasks shown to be highly sensitive to cognitive impairments, not only in acute patients but also in remitted ones (e.g. vigilance, verbal memory and executive functions—Kelly et al., 2000; Riley et al., 2000).

In this study, we hypothesized that training would enhance performance on attentional tests. Furthermore, as attention is also related to higher cognitive abilities (Shallice, 1988), we also hypothesized that attentional improvement would be transferred to memory and executive functioning performance.

2. Method

2.1. Subjects

Thirty-nine stable schizophrenic outpatients from several rehabilitation centers were included in the study. To be recruited for the study, patients had to receive a diagnosis of schizophrenia according to DSM-IV criteria (American Psychiatric Association, 1994). Those with disruptive behavior, abuse or dependence on alcohol or other drugs, or with evidence of neurological illness or injury, were excluded. Admission to the study required both subjective complaints of attentional problems (i.e. complaining of poor attention in noisy places or being unable to follow a conversation) and no participation in any cognitive rehabilitation program before and during the study. All the patients were currently treated with neuroleptic medication.

Participants were randomly assigned to one of the two groups: APT group or no-training group. The latter group continued their regular attendance at their rehabilitation centers, although they did not receive specific treatment for cognitive deficits. Fifteen of the 39 patients originally recruited were excluded from the study because of psychotic decompensation (seven subjects), change of address (three subjects), dropout (three subjects from the APT group, none from the control group), or dual diagnosis (two subjects).[1] The final sample included in the statistical analyses comprised 13 patients in the APT group and 11 in the control group.

2.2. Assessment tasks

Cognitive tests were selected to measure various cognitive areas such as attention (sustained, selective, divided and alternating), memory and exec-

[1] No significant differences between excluded and included patients were found on the data gathered: gender, age, duration of illness, number of previous hospitalizations, dose of neuroleptics, mental state, global functioning, or symptoms.

utive functions. Mental state, symptomatology and global functioning were also assessed.

The attentional tests included simple and degraded CPT versions; a cancellation task that is an adaptation of the Toulouse–Pieron test; a dichotic-listening task that was devised by the second author; a dual task that consisted of asking participants to simultaneously perform the cancellation task and the dichotic-listening task; forms A and B of the Trail Making Test; the Paced Auditory Serial Addition Task (PASAT); and an Everyday Attention Questionnaire. Memory was assessed with the Spain-Complutense Verbal Learning Test (TAVEC—the Spanish version of the California Verbal Learning Test). The Wisconsin Card Sorting Test (WCST) was used to assess executive functioning.

Following a similar procedure to that used by Velligan et al. (1996), a Global Attention Score, used as a composite measure of attention functioning, was calculated by averaging the hit means of the following tasks: simple and degraded CPT, cancellation, dichotic listening, dual task and PASAT. Higher scores indicate better attentional functioning.

Symptomatology was rated based upon the Brief Psychiatric Rating Scale (BPRS). Positive symptoms were also measured with the Scale for the Assessment of Positive Symptoms (SAPS), and negative symptoms were assessed with the Scale for the Assessment of Negative Symptoms (SANS).

Details of the tests administered, including a brief description, and scores generated are shown in Table 1.

2.3. Attention training exercises

The APT (Sohlberg and Mateer, 1987), a treatment program developed to remedy attentional deficits in brain-injured persons, was used as the treatment condition of this study. The APT is a hierarchical multilevel program that treats four levels of attention (sustained, selective, divided and alternating attention). This is accomplished by using four different types of material (visual cancellation, auditory cancellation, mental control and daily life attentional tasks) consisting of exercises arranged in hierarchies of difficulty that are based both on the complexity of the tasks and the processing speed requirements. Progression through one module builds skills that are thought to be necessary for performing in subsequent modules.

Details of the tasks administrated are shown in Table 2.

2.4. Procedure

After providing informed consent, patients participated in a clinical interview with the first author (BL) to confirm, by means of a symptom-based checklist, that DSM-IV criteria for schizophrenia were met. During the interview, the patients were assessed both with the Mini-Mental State Examination to screen for neurological illness (the inclusion criterion was a score over 23) and with the Everyday Attention Test to check subjective attention complaints (the inclusion criterion was failure in critical items of this 25-item test: becoming distracted in easy tasks and having trouble maintaining attention).

All the participants then met individually with the same clinician for assessment sessions that totalled 41 h over a period of 2 weeks. All these sessions took place in a quiet room at the rehabilitation center.

After the assessment, the participants were randomly assigned, in sequence, to one of the two groups. Patients in the intervention group were trained by using the APT. The training tasks were administered by trained research assistants (detailed training manuals, developed in pilot research, were used to teach the trainees). The same person acted as the trainer during the entire treatment.

The first session was spent explaining the process of the program. Compared with most rehabilitation programs, one of the more distinctive characteristics of the APT is that training is individually tailored to patients' cognitive abilities. Thus, following the APT format, the trainer had to locate the rehabilitation starting point for each patient. This starting point had to be found for each training material (visual and auditory cancellation and mental control). The starting point was

Table 1
Assessment tasks

Test, reference and score used	Description	Cognitive functions assessed
Symptoms, mental state and social functioning		
Mini-Mental State Examination (MMSE, Folstein et al., 1975): total score	The MMSE contains 5 parts: orientation, immediate memory, attention and arithmetic, and delayed memory and language.	Mental state
BPRS (Overall and Gorham, 1962): total score	The BPRS is a 24-item scale assessing symptomatology on a series of 7-point scales.	Symptoms in schizophrenia
SAPS (Andreasen, 1984): each section score	The SAPS is a 34-item scale. It yields 4 factor scores: hallucinations, delusions, bizarre behavior, and formal thought disorders.	Positive symptoms
SANS (Andreasen, 1983): each section score	The SANS is a 25-item scale. It yields 5 factors: affect, alogia, avolition, asociality and attention.	Negative symptoms
Global assessment of functioning (GAF, American Psychiatric Association, 1994): total score	The GAF is a rating scale to assess the way the subject functions in the environment.	Global functioning
Attention		
CPT (Nuechterlein and Asarnow, 1987): hit rate, false-alarms rate, RT correct, RT false alarms, response bias and sensitivity	The simple version requires the subject to press a button whenever the target number '0' appears on the screen. The degraded version is the same, but the stimulus is degraded (high-processing load version).	Visual sustained attention and psychomotor speed
Cancellation task (López Luengo, 2000): total correct, total false alarms	In this pen-and-paper test, the subject has to cross out the target in a 144-item matrix.	Visual selective and sustained attention
Dichotic listening shadowing task (Vázquez et al., 1990): total correct and total errors	Subjects have to listen to and repeat schizophrenia-related words presented to the right ear while ignoring neutral words presented to the left ear ('shadowing').	Auditory selective attention
Dual task (López Luengo, 2000): same for each separate task	Subjects should respond simultaneously to the cancellation task and the dichotic-listening task.	Visual and auditory divided attention
PASAT(Gronwall, 1977): first and fourth subtest total hits and total false alarms	The subject has to add each number to the one immediately preceding it on a total of 61 numbers on a list presented at 2.4-, 2-, 1.6- and 1.2- s rates.	Auditory selective and sustained attention, information-processing speed
Trail Making Test (A and B, Reitan and Davidson, 1974): total time and total errors	In part A, subjects must draw a line from the number 1 to consecutive numbers. In part B, subjects must draw a line, shifting numbers–letters, from 1 to A, 2 to B and so on.	Visual sustained and alternating attention, cognitive flexibility
Everyday Attention Questionnaire (EAQ, Martin, 1986): each section mean score	Contains 15-items (score from 0 to 4 by frequency) related to different aspects of attentional behavior in daily life.	Everyday life sustained, selective and divided attention

Table 1 *(Continued)*

Test, reference and score used	Description	Cognitive functions assessed
Memory		
Spain-Complutense Verbal Learning Test (TAVEC, Benedet and Alejandre, 1998): short-term recall total, delayed recall total, discriminability and response bias	The subject is asked to recall a list of 16 words at the end of each of five consecutive trials. After this, a new 16-word list has to be recalled. Then, the subject has to remember the words from the first list with and without cues. This is repeated 20 min later. The last part is to recognize the first-list words from a word list.	Learning, immediate and long-term verbal recall, recognition
Executive functions		
WCST (Heaton, 1981): categories completed, percent correct, percent perseverative errors	This 128-item test requires subjects to match stimulus cards containing different geometric shapes that vary in color and the number of items per card. The subject has to find the rule for the correct matching. The examiner just responds 'right' or 'wrong' after each response. The rule is changed after 10 consecutive correct matches.	Cognitive flexibility, solving problems

the exercise at which the patient failed two times consecutively. Once the starting-point was located, each subsequent training session followed a uniform pattern: The first few minutes of each session were spent explaining what attention is and how attentional problems can be detected; secondly, the repeated practice for every kind of material commenced. Participants received practice with exer-

Table 2
Treatment tasks used in attention training (Sohlberg and Mateer, 1986)

Sustained attention
Cancellation tasks with figures and numbers (eight pen-and-paper tests).
Attention tapes 1–8 (strings of auditory stimuli with response requirements of increasing difficulty).
Serial numbers (six number-manipulation exercises—e.g. subtracting numbers).
Everyday life tasks (e.g. finding a target in mazes, phone guides, maps…).

Selective attention
Cancellation tasks with figures and numbers (24 pen-and-paper tests with visual distracters).
Attention tapes 9–16 (strings of auditory stimuli recorded with background noise).
Everyday life tasks (finding a target in mazes, phone guides and maps with background music).

Alternating attention
Eight cancellation tasks figures and numbers (every 15 s, the target changes).
Addition/subtraction flexibility, odd/even number flexibility, size Stroop, position Stroop.

Divided attention
Simultaneous multiple attention (24 tapes and cancellation tasks).
Multilevel card sort (to group cards by suit and also to turn over the card that contains a specific letter).
Everyday life tasks (to play a game).

Table 3
Description of the performance of each patient in the APT

Patient	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean
Number of sessions	90	62	58	45	38	30	63	61	54	19	52	25	34	48.54
Duration (weeks)														
Actual	48	60	56	76	36	40	50	40	44	8	56	27	22	43.31
Optimal[a]	45	31	29	23	19	15	32	31	27	10	26	13	17	24.46
Session (min)														
Shortest	10	20	20	30	15	25	30	20	15	20	30	40	15	24.62
Longest	60	50	80	75	50	60	70	95	60	80	90	95	40	69.62
Average	35	33	49	48	32	42	49	55	34	48	46	54	31	42.77

[a] Optimal duration of the training if the patient would have been trained twice a week without missing any sessions.

cises for each training material during the session. Thus, in each session, the patient was trained with visual cancellation tasks, auditory cancellation tasks, mental control tasks and everyday life tasks.

Exercises were presented in graded difficulty, so that participants began practice at relatively easy levels and proceeded to more difficult levels with improved performance. Tasks were administered repeatedly until a double success criterion was met (i.e. a success rate of at least 85% in the task more than three consecutive times), and task performance lasted no longer than 5 min. Those two criteria simultaneously defined whether the performance was sufficiently adequate to proceed to a more difficult task. Systematic review of participants' performance and corrective feedback was built into the process.

The average treatment duration was 48.5 sessions (S.D. = 19.4) and, depending on subject availability, two to three training sessions were scheduled per week. The average session time was 42.6 min (S.D. = 8.7). More detailed information about the treatment for each patient is shown in Table 3. All patients who began the training process finished the program.

Once the intervention phase was over, the participant was retested with the same tasks as in the assessment phase. Control group participants received no attentional training, but they participated in the same multidisciplinary day-treatment program as did the experimental group. All the participants in the control group received the same assessment in the same order. To determine when a patient should receive post-assessment, a yoked control process was used. Thus, every patient from the control group was paired in gender, age and duration of illness with a participant from the APT group. Thereby, if a patient from the APT group had a 6-month interval between the assessments, his or her paired control subject would also be reassessed 6 months after the first assessment.

2.5. Data analyses

To determine whether there was any significant improvement after treatment, a series of repeated measures 2 (Group: APT group vs. Control group) × 2 (Time: Pretest vs. Post-test) ANOVAs were conducted on each measure listed in Table 1. A series of ANCOVAs were performed as well for all the dependent variables, using age, gender, duration of illness, number of previous hospitalizations and type of schizophrenia as covariates. None of these covariates affected the results found in the ANOVAs.

3. Results

Demographic, clinical and functioning variables for the two groups of subjects participating in the study are shown in Table 4. There were neither significant group differences in gender, age, duration of illness, number of previous hospitalizations, dose of neuroleptics, mental state, global functioning or symptoms, nor were significant between-group differences found in the test–retest interval between assessments. However, significant differences were found in bizarre behavior on the SAPS

Table 4
Demographic and clinical characteristics of the patients

	APT group ($n=13$)	Control group ($n=11$)
Sex, % male	92	73
Age, years	34.7 (8.4)	32.2 (8.9)
Duration of illness, years	13.9 (5.4)	12.4 (10.0)
Number of previous hospitalizations	4.3 (4.5)	3.4 (3.9)
Type of schizophrenia, % paranoid	46	82
Dose of neuroleptics, in chlorpromazine units	490.3 (219.4)	387.4 (254.0)
Mini-Mental State, total score	27.4 (2.0)	26.4 (1.9)
BPRS, total score	37.3 (7.9)	37.4 (13.6)
SAPS		
Hallucinations	0.8 (1.6)	1.6 (2.3)
Delusions	2.8 (1.7)	2.8 (2.3)
Bizarre behavior[a]	0.9 (1.2)	0 (0)
Formal thought disorder	1.6 (1.4)	1.1 (1.6)
SANS		
Affect	2.5 (1.7)	2.4 (2.0)
Alogia	1.6 (1.5)	1.7 (1.8)
Avolition-apathy	1.8 (1.4)	2.0 (1.7)
Anhedonia	3.4 (0.9)	3.0 (1.2)
Attention	1.0 (1.3)	0.6 (1.2)
GAF	45.5 (15.9)	46.8 (20.8)
Pre-post interval, months (S.D.)	14.7 (4.9)	13.7 (3.9)

Note: Results show means and S.D. (in parentheses).
[a] $P<0.05$.

(the APT group showed a higher score on this variable than the control group).

Mean scores on cognitive performance by group for pre- and post-assessment are presented in Table 5. Previous analyses showed that all measures were normally distributed, and the assumptions to run parametric ANOVAs were met. There were no significant differences for any attentional variable, with the exception of the total number of correct responses in the dichotic listening task under the dual condition [$F(1, 20)=4.434$, $P<0.05$]: patients in the control group improved significantly from pre-test to post-test whereas the APT group did not.

With regard to the memory tasks, no significant effects were found. In relation to executive functioning, there was a significant interaction in some WCST measures. As detailed in Table 4, participants in the APT group showed a significant increase in the total number of categories completed [$F(1, 18)=8.201$, $P<0.01$] and in the percentage of correct responses [$F(1, 18)=4.441$, $P<0.05$], whereas patients in the control group did not show any significant improvement from pre-test to post-test.

A similar series of ANOVAs were performed on medication, global functioning, and symptoms in order to determine their evolution throughout the study. No significant main or interaction effects were found.

Lastly, in order to establish the degree of association between the amount of time an individual participated in the training program and the amount of change in cognitive function, a correlation between the number of training sessions and the percentage of improvement on the assessment tasks was calculated.[2] No significant relationship was found.

[2] This percentage of improvement was calculated for every dependent variable ((post−pre/pre)100).

Table 5
Pre- and post-treatment mean scores on clinical and information-processing measures

Test	Value	Treatment group		Control group	
		Pre-test mean score (S.D.)	Post-test mean score (S.D.)	Pre-test mean score (S.D.)	Post-test mean score (S.D.)
Simple CPT	Hit rate	0.974 (3.872)	0.949 (0.009)	0.871 (0.193)	0.855 (0.15)
	RT hits	610.5 (87.7)	610.8 (92.2)	633.8 (74.07)	643.9 (126.7)
	False-alarm rate	0.001 (0.002)	0.001 (0.003)	0.004 (0.008)	0.004 (0.005)
	RT false alarms	540.5 (273.7)	521.5 (180.4)	526.2 (103.8)	478.4 (156.1)
	Response bias	0.373 (0.737)	0.342 (0.533)	0.353 (0.572)	0.509 (0.25)
	Sensitivity	0.990 (0.001)	0.983 (0.004)	0.955 (0.007)	0.952 (0.004)
Degraded CPT	Hit rate	0.622 (0.294)	0.604 (0.291)	0.519 (0.3)	0.532 (0.307)
	RT hits	739.0 (204.2)	691.0 (154.73)	754.5 (169.7)	727.6 (170.5)
	False-alarm rate	0.144 (0.264)	0.009 (0.134)	0.008 (0.1)	0.007 (0.01)
	RT false alarms	606.4 (120.1)	580.7 (126.5)	645.8 (72.89)	608.4 (128.4)
	Response bias	0.35 (0.588)	0.46 (0.527)	0.519 (0.455)	0.521 (0.308)
	Sensitivity	0.831 (0.118)	0.855 (0.009)	0.81 (0.12)	0.863 (0.102)
Cancellation task	Total correct	95.4 (6.4)	97.8 (4.1)	91.2 (5.9)	92.4 (8.3)
	Total false alarm	0.7 (1.8)	0 (0.1)	0.8 (1.4)	0.4 (1.2)
Dichotic listening	Total correct	101.5 (21.6)	106.6 (15.6)	94 (22.5)	88.4 (25.2)
	Total errors	3.5 (3.3)	2.5 (3.5)	4.1 (3)	2.9 (2.5)
Cancellation task (dual task)	Total correct	96.3 (4.7)	97.2b(2.6)	89.5 (8)	91 (7.5)
	Total false alarm	0.3 (0.4)	0.2 (0.3)	1.3 (2.3)	0.8 (1.4)
Dichotic listening (dual task)	Total correct*	187.2 (40.1)	186.3 (50.8)	116.8 (48.8)	142.9 (65.2)
	Total errors	3.5 (3.3)	2.5 (3.5)	4.1 (3)	2.9 (2.5)
PASAT	Total correct 1st	30 (9.6)	33.4 (12.5)	23.9 (8.8)	33.3 (7.5)
	False alarms 1st	14.7 (12.1)	6.2 (2.5)	6.3 (3)	5.7 (5.7)
	Total correct 4th	14 (8)	21.1 (4.3)	15.4 (7.9)	14.8 (6.6)
	False alarms 4th	18.1 (17.9)	4.5 (2.5)	39.7 (8.9)	10.8 (16.2)
TMT	Total time (a)	59.6 (29.8)	60.8 (40.6)	72.4 (45.9)	69.5 (46.4)
	Total errors (a)	0.1 (0.3)	0.1 (0.3)	0.2 (0.4)	0.4 (0.9)
	Total time (b)	150.4 (120.7)	166.2 (164.5)	229.2 (185)	189 (118.5)
	Total errors (b)	0.9 (1.1)	0.9 (1.4)	2.1 (1.4)	1.4 (1.2)
Global Attention Score	Total score	73.9 (7.7)	77.3 (6.5)	71.9 (9.1)	71.4 (15.5)
EAQ	Mean section 1	1.8 (0.8)	1.8 (0.7)	1.8 (0.8)	1.3 (0.9)
	Mean section 2	2.3 (0.9)	2.3 (0.7)	2.6 (0.5)	2.8 (0.5)
	Mean section 3	3.2 (0.9)	3 (0.8)	3.1 (0.6)	3.6 (0.9)
	Mean section 4	2.2 (0.5)	2.3 (0.8)	2.4 (0.8)	3.1 (0.9)
	Mean section 5	2.3 (0.9)	1.9 (1)	2.7 (0.7)	2.7 (0.5)
TAVEC	Immediate correct	5 (2.6)	5.8 (2.2)	4.4 (1.4)	5 (2.1)
	Delayed correct	8.7 (4.2)	10.1 (3.6)	7.3 (3.1)	7.6 (3.1)
	Discriminability	85.3 (10.9)	91.3 (8.5)	88.5 (6.7)	88 (8.1)
	Response bias	0.4 (0.4)	0.1 (0.4)	−0.2 (0.6)	−0.2 (0.5)
WCST	Total categories**	2.4 (1.7)	3.7 (2.4)	2.8 (2.3)	2.7 (2.3)
	% correct*	48.4 (14)	61.1 (24.1)	52.2 (19.2)	48.2 (20.3)
	% perseverations	27.9 (11.1)	23.4 (20.7)	28.5 (18.8)	29.6 (21.5)

Note: The Global Attention Score is the result of combining hit means from the following measures: CPT, cancellation task, dichotic listening, dual task and PASAT measures.

* $P < 0.01$.

** $P < 0.05$.

4. Discussion

Against our prediction, highly structured training did not improve attentional functioning, as measured by a broad array of both clinical and information-processing measures. As attentional performance did not significantly improve, we consequently expected no further changes either in memory or executive functioning. However, unexpectedly, some executive functions changed in the APT group. We found that individuals receiving attentional training showed a significant improvement in the total number of categories completed and in the percentage of correct responses on the WCST.

Although the APT is a program specifically designed to remedy attention, we found that, in our sample of schizophrenic patients, it was not effective to improve their attention. Therefore, should we conclude that attention in schizophrenia cannot be enhanced? It is important to note that, although we did not find significant improvements on specific attentional tasks, we did find that the patients' performance within the APT improved over time (i.e. patients' performance starting point for each task and subtask was in the upper levels at the end of the training). This means that patients' attention improved with practice, but this improvement was linked to the task itself. Other studies have also found practice effects in schizophrenia in the performance on certain tests such as the California Verbal Learning Test (Hawkins and Wexler, 1999) and on other memory and perceptual tasks (Wexler et al., 1997). Therefore, because our outcome measures are different from the measures linked to the APT itself, we conclude that, although APT may enhance patients' performance within the program tasks, generalization is not transferred to the broader array of cognitive outcome tasks included in our study.

Nevertheless, in a study by Medalia et al. (1998) with a sample of schizophrenic patients, the authors found that, using the CPT as an outcome measure, patients' performance on that task improved after a training program to remedy attention. As the CPT performance was not directly trained, this indicates that the enhancement on the treatment task was transferred to the outcome measure. One of the differences between the study by Medalia et al. and ours is that, in their study, they trained patients' reaction time and we did not.

If attentional deficits are trait-like characteristics of schizophrenia, then changes in the function itself may be difficult to obtain even after administering effective antipsychotic medication to patients (Liu et al., 2000). On the other hand, as indicated by Wykes and van der Gaag (2001), perhaps in the future, cognitive rehabilitation should focus not so much on improving basic cognitive functions (e.g. attention) but rather on higher levels of cognition (e.g. problem-solving), where generalization to everyday life tasks may be more direct. However, as data on clinical interventions of cognitive rehabilitation are still scarce, we believe that any attempt is ethical and scientifically essential.

With regard to our finding about the improvement of executive function parameters, it must be emphasized that the WCST was not used as a practice task. Yet, a number of studies have shown that it is possible to improve WCST performance, at least over short periods of time. Several studies have shown that improvements on the WCST can be achieved through different methods: by modifying the verbal information provided for task development (Rossell and David, 1997), by teaching individuals directly how to complete the task (Goldberg et al., 1987; Goldberg and Weinberger, 1994), by providing a simple information-processing technique (Stratta et al., 1996), by using cueing techniques (Goldman et al., 1992), or by instructional and learning-based techniques (Young and Freyslinger, 1995; Kern et al., 1996). Unfortunately, all these studies have used the WCST both as an outcome measure and a training task. However, when studies have used training tasks with other problem-solving tasks instead of with the WCST, generalization of learning has not been observed (Bellack et al., 1996). Improvement in the WCST performance when using a different training program (which did not include the WCST) has also been found in another study (Bell et al., 2001).

The mechanisms whereby APT might improve executive functioning deserve further discussion. An analysis of the efficacy of the studies on

cognitive rehabilitation suggests that, rather than practice, the procedures used to verbalize the instructions, provide corrective feedback, and teach processing strategies are the most effective (Perry et al., 2001; Wykes and van der Gaag, 2001). But other variables, such as increased self-esteem or perceived self-efficacy, may also play a role in the improvement (Wykes et al., 1999), so that future studies should analyze in more detail the results not only over a broad range of measurements, as we tried to do in our study, but also the pathways by which this change is produced. A study by Rossell and David (1997) attempted to clarify which aspects of the WCST schizophrenic patients would find most difficult. Their results suggested that encouraging the patients to plan and pace their performance and to detect their errors would be the most successful strategies to improve WCST scores in people with schizophrenia. It is interesting that, according to our results, APT seems to help patients learn to plan their actions and to analyze the task procedures before starting the exercises, and thus, to avoid impulsive responses. As there was no change in medication doses or in clinical symptoms during the study, this rather nonspecific component of the APT program may have played an active role in the improvement of executive functions. Thus, future studies should investigate in detail the specific pathways by which the APT or similar training programs might affect executive functioning. Yet, if this psychoeducational hypothesis were true, it is rather paradoxical that false-alarm rates in the CPT (a measure sensitive to attentional disinhibition deficits) do not show any significant improvement over treatment.

The present study suggests that the APT is not useful for improving attention in persons with schizophrenia. Although patients may judge it as personally useful (López-Luengo and Vázquez, submitted). However, we have shown the feasibility of using attention practice to ameliorate executive functioning in these patients. Moreover, the most important clinical issue in the value of a rehabilitation program is to determine whether its effects generalize to other impaired functions and, above all, to social functioning and quality of life. Future research should establish which elements of the program are responsible for this enhancement and then use that information to design specific programs to remedy executive functions and enhance social and intellectual functioning.

The APT had been previously used with head-injured people and the assessment protocol typically included few measures. We have tried to test the utility of that well-known and widely used program in the context of a psychiatric problem including a broad range of outcome measures. The unexpected pattern of positive results found in our study should encourage researchers in this field to analyze the APT components that may be responsible for the changes in measures related to executive functioning. Furthermore, in order to learn more about specific effects of the program, the use of the training program should be extended to different type of patients who also show prominent attentional deficits (e.g. manic patients) (Clark et al., 2002; Wilder-Willis et al., 2001).

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