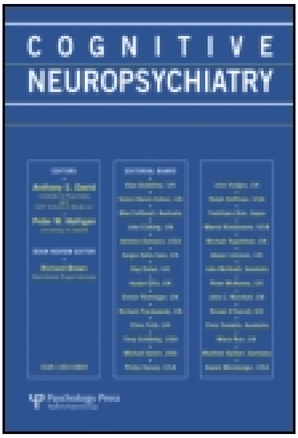

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Is there any impact of cognitive remediation on an ecological test in schizophrenia?

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Introduction. Cognitive deficits are commonly reported in schizophrenia and have a significant impact on the daily life of patients and on their social and work inclusion. Cognitive remediation therapies (CRT) may enhance the capabilities of schizophrenia patients. Although social and work integration is the ultimate goal of CRT, previous studies have failed to carry out a detailed assessment of the effects on everyday life.
Methods. Fifty-nine schizophrenia patients were randomised into two groups (remediation or usual treatment) to test the effects of a new remediation programme, which included both rehearsal and strategy learning, on cognitive functions. An ecological test was used to evaluate its transfer to daily living skills.
Results. Cognitive improvements are revealed in CRT patients, mainly in memory and executive functions. Patients showing some deficiencies to perform the ecological test had better scores after the CRT. Moreover, they significantly improve their social activity scores.
Conclusions. CRT would facilitate mental load monitoring by enhancing or reallocating cognitive resources, facilitating the patient's organisation and autonomy. The rehearsal learning approach improves the ability to carry out automatic

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operations that are less demanding in terms of cognitive resources, thereby increasing the resources available for acquisition and efficient use of strategies provided during the strategy learning approach.

Keywords: Cognitive remediation therapy; Ecological test; Schizophrenia.

INTRODUCTION

Schizophrenia is a disabling psychiatric disorder, with 85% of patients presenting with neurocognitive deficits (Palmer et al., 1997) in measures of attention, learning and memory, problem solving, language, and/or sensory-motor skills (Heinrichs & Zakzanis, 1998; Saykin et al., 1991, 1994). These deficits exist at disease onset, are relatively resistant to the effects of antipsychotic medication, and are closely linked to poor outcome (Green, Kern, Braff, & Mintz, 2000; Kurtz, Seltzer, Ferrand, & Wexler, 2005; Revheim et al., 2006), social disability experienced by schizophrenia patients (Bellack, Gold, & Buchanan, 1999), and compliance (Green & Nuechterlein, 1999).

The results of different neuropsychological interventions are emerging rapidly. Despite some exceptions (Medalia, Revheim, & Casey, 2000), a meta-analysis by Krabbendam and Aleman (2003) showed that cognitive remediation therapies (CRT) improve task performance of schizophrenia patients in measures of working memory, reasoning/executive functions, verbal and spatial episodic memory, and proceeding speed (Kurtz, Seltzer, Shagan, Thime, & Wexler, 2007). The mechanisms of these effects remain unclear. An underlying assumption is that repeated practice either directly strengthens the requisite neurocognitive skills required to perform these tasks or enables patients to develop compensation strategies for remaining cognitive difficulties with generalisation to unpractised neuropsychological tests demanding the same amount of resources. The reported results show large differences in patient characteristics, number of sessions administered, duration of overall training, outcome measures selected, individual or group training, and control conditions (see, for reviews, Krabbendam & Aleman, 2003; Twamley, Jeste, & Bellack, 2003).

Two approaches are used in CRT programmes. In the compensation approach, individuals learn strategies to perform tasks in a different way. In the restitution approach, individuals repeat exercises on a particular impaired cognitive function. According to Krabbendam and Aleman (2003), programmes aimed at strategy learning (i.e., compensation) might be superior to programmes adopting rehearsal training (i.e., restitution). Moreover, McGurk, Twamley, Sitzer, McHugo, and Mueser (2007) demonstrated in a meta-analysis that cognitive remediation programmes including strategy coaching had stronger effects on functioning than programmes focusing only on drill and practice. In a previous study (Bellot et al., 2004), we trained 15 schizophrenia patients with the paper-and-pencil compensation approach. Results showed some improvements in memory and executive functioning but failed to show any improvement in attentional processes. In this new study, we used computerised exercises with a restitution approach focusing on attention training. Indeed, Royer et al. (2009), using fMRI, observed that schizophrenia patients have an increased activity in the attentional frontoparietal network when performing two different executive tasks. This overactivity is likely to reflect increased efforts when patients performed the task and is in line with the results of Mendrek et al. (2005). Few studies have looked at the transfer of CRT to patients' daily life, although applying newly acquired cognitive skills to the real world is vital (Wykes & Huddy, 2009). Ecological tasks can be used to measure this transfer. Wykes, Reeder, et al. (2007) used the six-element ecological test but did not find any improvement after CRT. However, unlike the ecological shopping test (Martin, 1972), this test does not correspond to any activity in daily life.

In the present study, we used a design without social training in order to individualise effects of a "pure" cognitive training and we hypothesised that an intensive and long duration CRT programme, with compensation and restitution approaches, might improve attentional processes and facilitate the transfer of new cognitive skills to an ecological test.

METHODS

Study design

The study was approved by the local ethics committee. All patients gave written, informed consent. The recruited patients who fulfilled the criteria (as specified in the Participants section) were assessed before (T0) and after (T1) 6-month treatment (CRT group), or before and after a 6-month interval (treatment as usual [TAU] group) using a neuropsychological test battery assessing attentional, memory, executive, and adaptive (i.e., ecological test) functions. After the first assessment (T0), they were randomly allocated to one of two groups (CRT or TAU) using a centralised randomisation procedure (Figure 1).

In both groups, patients underwent a medical survey and carried out their social activities as previously.

In the CRT group, we used the compensation approach for strategy learning and the restitution approach mainly for the attentional functions with repetitive exercises. The training programme was intensive, 6 hours/week for 6 months.

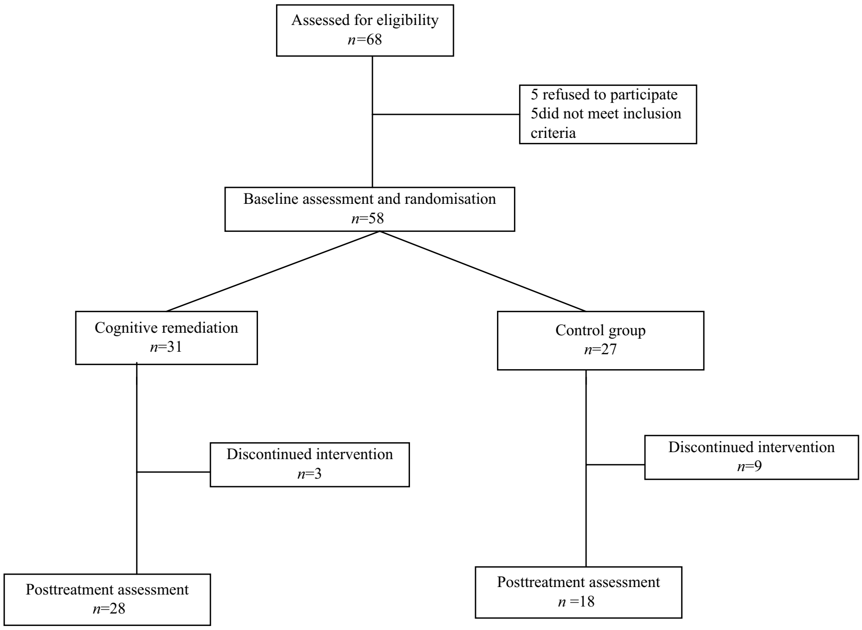

Figure 1. Progress through the phases of the randomised trial.

Study participants

On the basis of preliminary results (Bellot et al., 2004), a power calculation was computed with $\alpha = .05$, $\beta = .8$, and $\triangle = 15$ on the shopping test. Then, 58 patients with DSM-IV diagnosis of schizophrenia were included: 31 in the CRT group and 27 in the TAU group (Table 1). Inclusion criteria were: ≥ 70 intelligence quotient (IQ; Wechsler Adult Intelligence Scale [WAIS-R]; Britton & Savage, 1966), cognitive deficiency in at least one attention TEA test (score below the second percentile; Zimmermann & Fimm, 1994), and/or on memory (score below 2 standard deviations [*SD*] in the Grober & Buschke test, 1987), and/or on executive functions (score below the fifth percentile; Roussel & Godefroy, 2008).

Exclusion criteria were: mental retardation (IQ < 70), traumatic brain injury, presence or history of any neurological condition, and criteria for substance abuse or dependence.

All patients received antipsychotic medication without any change for the previous month and during the treatment phase.

Three patients dropped out in the CRT group and eight in the TAU group, one being excluded because he began another extra protocol of cognitive remediation programme. So, finally, 28 patients in the CRT group

TABLE 1
Demographic and clinical characteristics of the 46 schizophrenia patients who completed the study

Variable	*CRT (n = 28)*	*TAU (n = 18)*	*t-test*	*p-value*
Age, mean (*SD*)	31.0 (7.6)	35.5 (9.0)	−1.8	.08
Education (years), mean (*SD*)	12.0 (2.4)	10.5 (3.0)	1.9	.07
Duration of illness (years), mean (*SD*)	10.6 (7.8)	11.8 (8.6)	−0.5	.62
Total IQ, mean (*SD*)	96.9 (15.9)	103.6 (23.1)	−1.1	.26

CRT: cognitive remediation group; TAU: treatment as usual (control) group; IQ: intelligence quotient; SD: standard deviation.

and 18 in the control group were included in the statistical analyses. We performed nonparametric comparisons (*U*-test) between the patients who completed the study and those who did not. These analyses did not show any significant difference between these two subgroups ($p > .05$).

Measures

Cognitive functions were assessed by trained neuropsychologists at T0 and T1 using the following tests: (1) attention functions—computerised battery (Zimmermann & Fimm, 1994): (a) visual attention: arousal test, (b) shifting: cognitive flexibility test, (c) sustained attention: scanning test which consists in the detection an open square target among a matrix of closed squares, (d) inhibition: go/no-go, Stroop (Lowe, 1979), Hayling sentence completion test (Burgess & Shallice, 1996). In this test the subject has to complete a sentence where the last word is missing, first with a word in agreement with phrase, and second, with an unrelated word; (2) working memory: backward span test (WAIS-R; Wechsler, 1981), two-back test (Zimmermann & Fimm, 1994); (3) long-term verbal memory: the two parallel forms of Grober and Buschke test (1987); (4) executive function: verbal fluency test (Cardebat, Doyon, Puel, Goulet, & Joanette, 1990), modified Wisconsin Card Sorting Test (WCST; Nelson, 1976); (5) planning: ecological shopping test (“test des commissions”). In this test the subject fulfils a shopping list. Strategies depend on a limited amount of time, distances and timetables (e.g., stores are closed at 12 o’clock; the town house is opened from 8 to 10 a.m. . . .). The global score combines the time required to complete the test and the number of errors according to tables established in a normal population (Martin, 1972).

Finally, the patients' social and work activities at T0 and during the 6 months following T1 were also measured. This scale was designed for the study (Table 2).

Procedures

Training programme. The training programme was carried out for 6 hours/week for 6 months. Each 2 hour training session comprised paper and pencil exercises for 100 min in groups of six to eight persons, and individual training for 20 min with computer exercises.

Paper-and-pencil exercises. The cognitive training programme consisted of a series of exercises of increasing complexity. The first 6 weeks focused on attention, the next 3 weeks on language, the next 8 weeks introduced working and long-term memory, and the final 7 weeks focused on planning and problem solving. A psychologist assisted the patients in implementing strategies (i.e., compensation approach) in order to find a way adapted to the patient deficit to perform the exercises.

Computerised exercises. A computerised training programme (REHACOM® software; Schuhfried Company) was used. The exercises were repetitive (i.e., restitution approach) and consisted of five 10-min sessions with tasks designed to train vigilance, divided attention, reaction time, visuomotor and visuoconstruction skills. The level of difficulty increased with achievement, every 90 s. If the patient was not successful, another task was proposed. A psychologist introduced patients to the use of computers and assisted them whenever they needed help for some technical problem with the computer. But, under no circumstances did the psychologist either help the patient to do the task or teach him a strategy.

TABLE 2
Scale of patients' social and work activities

Score	*Activities*
0	No social or work activity
1	Day hospital
2	Social activity linked with the hospital
3	Social activity in an outside-hospital association (inducing personal initiation)
4	Rehabilitation activity in working field
5	Work training
6	Work activity

Statistical analysis

ANCOVAS were performed between groups to assess results using T0 scores, age, education, and duration of illness as covariates (Table 3). Age, education, and duration of illness did not influence the results. In order to take in account a possible ceiling effect, Mann-Whitney U and chi-squared tests were performed in the subgroup of patients showing some deficits (Tables 4 and 5).

Analyses were performed for the patients presenting deficits at T0 (U-tests) when the sample size was high enough. Deficits were estimated according to test manuals: below the second percentile for the TEA, below 1.65 *SD* of the mean normal score for verbal memory and the Hayling test, below the fifth percentile for Stroop, WCST, and verbal fluency (Roussel & Godefroy, 2008), and ≥ 3 for "forward span minus backward span". For the shopping test, we classified the patients in five categories depending on their

TABLE 3
Evolution of cognitive functions

	CRT		*TAU*		*ANCOVAS (p-value)*
	T0	*T1*	*T1*	*T0*	
Arousal (RT)	291 (58)	278 (55)	274 (48)	287 (55)	*ns*
Cognitive flexibility (errors)	7.86 (12.15)	7.5 (7.79)	8.78 (9.42)	11.06 (8.86)	*ns*
Scanning (omissions)	4.43 (3.18)	2.96 (2.3)	5.61 (4.34)	6 (4.99)	.018
Go/no-go (errors)	2.39 (2.71)	1.18 (1.36)	1.72 (2.7)	1.94 (2.18)	*ns*
Stroop (errors)	0.61 (0.83)	0.26 (0.45)	0.56 (1.2)	0.56 (1.04)	*ns*
Hayling (errors)	7.15 (2.78)	5.4 (2.73)	6.71 (5.06)	7.25 (5.24)	*ns*
N-back (omissions)	1.71 (1.51)	1.21 (1.13)	1.18 (1.63)	1 (1.41)	*ns*
Backward span	4.32 (0.72)	5.25 (1.18)	4.44 (1.15)	4.61 (1.24)	.01
Grober & Buschke (FR/48)	27.82 (5.57)	32.32 (5.85)	28.94 (6.71)	27.56 (5.98)	*ns*
Grober & Buschke (dFR/16)	10.43 (2.25)	12.18 (2.23)	9.83 (2.71)	10 (2.99)	.002
Verbal fluency	22.11 (8.23)	24.11 (9.1)	21.72 (7.47)	22.61 (6.44)	*ns*
WCST (categories)	5.68 (0.98)	6 (0)	5.56 (1.34)	5.39 (1.42)	.028
WCST (perseverations)	1.29 (1.61)	0.32 (0.55)	1.39 (2.3)	1.39 (2.48)	.024
Ecological test (/100)	60.79 (23.6)	68.64 (19.1)	60.78 (16.8)	64.44 (12.94)	*ns*
Social and work activities (/6)	1.46 (2.03)	2.96 (1.71)	2.89 (2.45)	2.72 (2.89)	*ns*

Mean (and standard deviation) are shown before (T0) and after treatment, or after 6 months (T1), and probability for ANCOVAS with T0 score, age, and duration of illness as covariates on every outcome measure in the cognitive remediation therapy (CRT) and treatment as usual (TAU) groups. CRT: cognitive remediation therapy; TAU: treatment as usual; T0: first evaluation; T1: second evaluation; RT: reaction times; FR: three free recalls; dFR: differed free recall; WCST: Wisconsin Card Sorting Test.

TABLE 4
Evolution of cognitive functions in patients showing a deficit

	CRT		*TAU*		
	T0	*T1*	*T0*	*T1*	*p*
Arousal (RT)	377 (30)	272 (33)			NA
No. in sample	7		NA		
Scanning (omissions)	9.6 (2.1)	3.6 (2.7)	11.14 (3.5)	8.86 (4.8)	.04
No. in sample	5		7		
Stroop (errors)	1.36 (0.67)	0.27 (0.47)	1.67 (1.21)	1.17 (1.94)	*ns*
No. in sample	11		6		
Hayling (errors)	10.4 (1.9)	6.4 (2.55)	12.5 (6.54)	9.83 (6.97)	*ns*
No. in sample	10		6		
N-back (omissions)	3.56 (0.53)	1.56 (1.42)			NA
No. in sample	9		NA		
Backward span	3.83 (0.41)	5.5 (1.76)			NA
No. in sample	6		NA		
Grober & Buschke (FR/48)	25.1 (3.73)	30.1 (4.86)	24.83 (4.88)	28.25 (6.64)	*ns*
No. in sample	20		12		
Grober & Buschke (dFR/16)	9.52 (1.78)	11.62 (2.29)	8.62 (2.22)	9.08 (2.66)	.009
No. in sample	21		13		
Ecological test (/100)	38.17 (10.45)	62.75 (21.68)	42.33 (7.9)	56.67 (12.11)	*ns*
No. in sample	12		6		

Mean (and standard deviation), and probability for group effects, CRT > TAU at the second evaluation (Mann-Whitney U-test). CRT: cognitive remediation therapy; TAU: treatment as usual; T0: first evaluation; T1: second evaluation; NA: not applicable because of too small a sample size; RT: reaction times; FR: three free recalls; dFR: differed free recall.

performances as originally described by Martin (1972). Then, we performed chi-squared tests on each of these categories in order to observe the classification improvement (Table 6) and to avoid any ceiling effect.

RESULTS

Whole group analysis

The CRT and TAU groups did not significantly differ with regard to age, duration of education, duration of illness, total IQ (Table 1), neuropsychological variables at T0, and type of treatment (i.e., typical vs. atypical

TABLE 5
Proportion (%) of patients who exhibited some deficits in each test at the first (T0) and at the second assessment (T1)

	CRT		*TAU*		
	T0	*T1*	T0	*T1*	χ^2
Arousal (RT)	25	14	17	6	*ns*
Cognitive flexibility (errors)	4	7	6	6	*ns*
Scanning (omissions)	18	4	39	22	*ns*
Go/no-go (errors)	11	0	11	11	7.174, $p = .007$
Stroop (errors)	43	0	33	6	*ns*
Hayling (errors)	36	21	33	22	*ns*
N-back (omissions)	32	14	17	17	*ns*
Backward span	21	7	17	17	4.045, $p = .044$
Grober & Buschke (FR/48)	71	43	67	50	*ns*
Grober & Buschke (dFR/16)	75	43	72	72	4.842, $p = .028$
Verbal fluency	11	4	0	6	9.24, $p = .002$
WCST (errors)	7	0	17	11	4.01, $p = .045$
WCST (perseverations)	4	0	6	6	*ns*

Statistical analyses were conducted with the Chi-squared test to determine the significance Group × Time. CRT: cognitive remediation therapy; TAU: treatment as usual; RT: reaction times; WCST: Wisconsin Card Sorting Test; n.s.: not significant.

antipsychotic drugs). ANCOVAS showed between groups difference at T1 for scanning omissions, backward span, Grober & Buschke differed free recall, WSCT categories, and perseverations (Table 3).

Even nonsignificant, every other differences were in favour of the CRT group. Test assessing attention, inhibition functioning, the shopping test,

TABLE 6
Proportion (%) of patients classified in each of the five categories described by Martin (1972) of the ecological "test des commissions"

	CRT		*TAU*	
Categories	*T0*	*T1*	*T0*	*T1*
Superior				
Scores 82–100	21	18	17	17
Middle superior*				
Scores 74–81	7	29	0	17
Middle				
Scores 51–73	29	32	50	38
Middle inferior				
Scores 30-50	32	18	33	28
Inferior				
Scores <.29	11	4	0	0

The percentage is noted in each group (CRT and TAU) at both assessments (T0 and T1). *$\chi^2 = 3.809$; $p = .05$.

and the scale of social and work activities did not show any significant difference using ANCOVAS. However, the score of social and work activities significantly improved (T1 vs. T0) in the CRT group compared to the TAU group ($p = .02$).

Deficit group analysis

Between-group comparisons showed an improvement in favour of the CRT group (Table 4) on scanning and Grober and Buschke's subtests.

Moreover, the percentage of deficient patients significantly decreased after CRT in the go/no-go, backward span, verbal fluency, and WCST subtests (Table 5).

Concerning the shopping test, the percentage of patients in the "middle superior" category (i.e., high score) significantly increases in the CRT group after remediation (7% vs. 29%) compared to the TAU group (Table 6). This revealed a significant effect of remediation on the "middle superior" category ($\chi^2 = 3.809$; $p = .05$).

DISCUSSION

In the present study, we hypothesised that training of "basic" function would reflect on more complex functions. A 6-month training programme was developed beginning with attention functions and ending with more complex problem-solving executive functions. However, cognitive processes, like inhibition or working memory (i.e., keeping tasks in mind, or inhibiting environmental stimuli; Stip, 2005) were constantly trained across the whole remediation programme.

Our results show an improvement in different cognitive functions in line with previous studies comparing CRT to usual care (Benedict et al., 1994; Burda, Starkey, Dominguez, & Vera, 1994; Medalia et al., 2000, 2001) and support the usefulness of CRT in targeting neurocognitive impairments and everyday functioning.

However, since each of our analyses failed to show any improvements in attentional "basic functions" (e.g., arousal, or cognitive flexibility), our results question the remediability of attention functions. This is in line with other studies (Benedict et al., 1994; Dickinson et al., 2010; Field, Galletly, Anderson, & Walker, 1997; Kurtz et al., 2007). Currently this question is approached thanks to cognitive "prostheses" (Sablier, Stip, & Franck, 2009), adapting the environment to the patients.

Yet, the deficit analyses demonstrated that the proportion of deficient patients on monitoring efficiency (i.e., go/no-go inhibition test) significantly decreased after CRT (Table 5). One might hypothesise that the rehearsal learning approach (i.e., repetitive computerised exercises) may be a prerequisite to the strategy learning approach. Indeed, the improved monitoring efficiency induces better resource management in working memory. Cognitive resources are consequently available for learning strategies.

Indeed, CRT had a strong positive impact on the retention and manipulation of information in working memory (i.e., backward span test), which is in line with previous works (Bell, Bryson, & Wexler, 2003; Kurtz et al., 2007; Offerlin-Meyer, Laroi, van der Linden, & Danion, 2007; Penadés et al., 2003; Reeder, Newton, Frangou, & Wykes, 2004; Wykes, Reeder, Corner, Williams, & Everitt, 1999). Several hypotheses have been put forward to explain this improvement, such as more available resources (Fleming, Goldberg, Gold, & Weinberger, 1995), a better allocation of these resources in working memory (Granholm, Asarnow, Verney, Nelson, & Jeste, 1996), or both.

Our results showed improvements in the CRT group in every test involving strategies (i.e., scanning, memory, WCST). Indeed, the improvements are effective on the outcomes that need some strategies learned during the remediation group (the free recall of Grober & Buschke test, the perseverations and categories of WCST, as well as on scanning omissions). Thus, it seems to be also useful for patients with schizophrenia to learn how to implement strategies rather than only performing cognitive exercises without learning any instructions. These results are in agreement with other studies exclusively using the compensation approach (Penadés et al., 2006;

Wykes et al., 1999). In a meta-analysis, Krabbendam and Aleman (2003) reported a slightly better effect of training programmes providing strategies compared to programmes consisting of rehearsal learning. Learning strategies may facilitate better performance in sustained attention, working and long-term memory, and executive function subtests, and may help patients in their everyday adaptation (Prouteau et al., 2004).

We also observed some improvements in long-term memory (Grober & Buschke test) linked to CRT in both types of analyses we performed (Tables 3 and 4, and 5). This could be explained by spontaneous learning of encoding and retrieving strategies (i.e., without the experimenter's help). This learning would reduce the impairment of contextualisation reported in schizophrenia patients (Rizzo, Danion, van der Linden, Grangé, & Rohmer, 1996; Schwartz, Deutsch, Cohen, Warden, & Deutsch, 1991). Teaching the patients to link the target information and its context (Tulving, Kapur, Craik, Moscovitch, & Houle, 1994) would improve learning and recalling new information. As reported by Bonner-Jackson, Haut, Csernansky, and Barch (2005), our results confirm that deep encoding allows patients to reach better memory performance.

Joint improvement of working memory and reasoning/executive function (i.e., backward span and WCST; Tables 3 and 5) domains in the CRT group is consistent with studies that have shown a close link between more elementary working memory functions and higher level reasoning and problem-solving skills (Gold, Carpenter, Randolph, Goldberg, & Weinberger, 1997). Indeed, improvements observed in the WCST suggest a link between improvements in working memory and improvement on more complex executive functions and organisation of behaviour (Baddeley, 1986, 1992; Cowan, 1988; Engle, 2002; Kane & Engle, 2003; Wykes, Reeder, et al., 2007).

Transfer to "real" life

We did not find any significant improvement on the ecological shopping test using whole group analyses (Table 3). Indeed, about 20% of the subjects had top performances (scores > 82) before the training. To deal with this ceiling effect, we classified patients in the five categories originally described by Martin (1972). We then observed a significant improvement for patients with lower performances (Table 6) in the CRT group compared to the TAU group. Thus, it seems reasonable to make the assumption that CRT had an impact on the real life of the patients through cognitive enhancement. Indeed, significant cognitive improvements were observed in the CRT group in the following outcomes: scanning omissions, backward span, differed free recall of Grober & Buschke, WCST (Tables 3 and 4), go/no-go, and verbal fluency

(Table 5). Moreover, we also observed an improvement in the real life (i.e., ecological shopping test, Table 6, and the social and work activities scale).

Ecological measures had rarely been used for CRT evaluation, with the exception of the six-element test, which showed a marginal effect (Wykes, Newton, et al., 2007). Indeed, very few ecological tests are available to observe the transfer of cognitive improvement to the real life. However, many authors investigated the effect of CRT on executive functioning, such as the WCST. The ecological shopping test, as well as the WCST, involves executive functions such as planning, decision making, and error correction. But in the shopping test, there is more information to process, so more inhibition and organisation are needed than in the WCST. This may explain why we observed stronger effects on the WCST (Tables 3 and 5) compared to the shopping test (Table 6).

Nevertheless it is only a realty-like assessment of everyday life. This is also in line with the improvement in social activity scores in the CRT group. The results on this social scale are very interesting, even if they do need some validity. McGurk and Meltzer (2000) showed that schizophrenia patients with a high performance in sustained attention, working and episodic memory, and executive functions are more engaged at work or in studies. After remediation, patients may find the idea of work easier, as suggested by Briand et al. (2005, 2006). This result is in agreement with other studies demonstrating an influence of executive deficits on social functioning (Buchanan & Carpenter, 1994; Mueser, Bellack, Douglas, & Wade, 1991; Wykes & Dunn, 1992), and with Lindenmayer et al. (2008), who suggested that taking part in a cognitive remediation programme may have professional benefits.

Only three patients abandoned their training, and they attended their sessions three times a week during the 6 months regularly with a high degree of commitment. In the TAU group, the patients' level of motivation to participate in the study decreased over time. Eight decided to leave the study early and refused to attend the second assessment. It is certainly possible to improve the implication of these patients in the study. For instance, one can imagine designing a nonspecific programme.

Our study presents several limitations. Age was somewhat younger and level of education higher in the CRT group, but these differences were not statistically significant. Moreover, the mean age of TAU patients is not sufficiently high (35.5 years) to raise concerns about cognitive impairments caused by ageing. Furthermore, their average IQ (103.6) was slightly higher than the CRT patients.

Our study is likely to present a lack of power due to the small sample size and hence caution must be exerted when interpreting the results. It is possible that our "intensive" programme may have led to a ceiling effect. The "optimum dosage" of remediation will require further investigations.

Finally, the lack of reliability of clinical assessment did not allow us to examine the eventual relationships between cognitive performance and different types of symptoms. However, some authors (McGurk et al., 2007) showed that cognitive remediation is associated with a small effect size for symptoms (0.28).

In conclusion, as described by Ericsson and Hastie (1994), our results suggest that some abilities that have been overlearned may become automatic and the strategies employed may be sufficient to increase the patients' abilities. Strategy automatisation through training requires working memory to simultaneously manage facilitation (via strategies) and information that is specific to the situation. The improvement of working memory observed in our study could allow patients to generalise the use of taught strategies during remediation. Thus, the strategies may change in a routine that imposed fewer constraints to the Supervisory Attentional System (Norman & Shallice, 1980).

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