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Cognitive Predictors of Social Functioning Improvements Following Cognitive Remediation for Schizophrenia

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A greater understanding of the links between cognitive and social functioning changes is needed to refine cognitive treatments for schizophrenia. To date, studies have been cross-sectional, and few have investigated the impact of cognitive change. This single-blind randomized controlled trial explored the links between changes in executive/memory functions and social behavior, as well as the moderating effect of cognitive remediation therapy (CRT). A total of 85 participants with schizophrenia received 40 sessions of CRT (an individual psychological therapy aiming to improve attention, memory, and problem solving) or treatment-as-usual. At baseline, social functioning was significantly associated with "verbal working memory," "response inhibition," "verbal long-term memory," and "visuo-spatial long-term memory," but not "schema generation," factors. However, only improvement in "schema generation" predicted improved social functioning. This was true whether or not participants had received CRT. These results suggest that cross-sectional associations between cognitive functions and social functioning may not offer the best means for identifying good targets for intervention. Improvement in the ability to generate new schemas has a beneficial impact on social functioning.

Key words: cognition/metacognition/psychological treatments/executive functioning/memory/cognitive remediation

Introduction

There is an increasing impetus to show that psychological treatments such as cognitive remediation and pharmacotherapy for cognitive function in schizophrenia lead to improvements not only in cognition but also in social functioning.[1] This goal is underpinned by the results of numerous correlational studies showing that executive functioning and memory are significant predictors of social functioning.[1–3] However, results from correlational studies cannot be used as evidence of a causal relationship. A better test is to observe the impact of cognitive change on functional behavior. Because cognitive function remains relatively stable throughout the course of schizophrenia,[4,5] studies investigating treatments designed to improve cognition are likely to prove more illuminating than those which rely on natural cognitive fluctuation.

A number of intervention studies, primarily of cognitive remediation, have shown that some executive and memory improvements are associated with subsequent social functioning change.[3,6–9] However, the specific cognitive improvements which predict social functioning change are not consistent between studies and are not always the same cognitive functions which show significant cross-sectional associations with social functioning. For example, Reeder and colleagues[6] showed that while a "response inhibition speed" factor was cross-sectionally associated with social functioning at baseline, change in a "stimulus-driven responding" factor, and not change in "response inhibition speed," predicted social functioning change following cognitive remediation therapy (CRT). There is also evidence to suggest that in some cases, cognitive change is only predictive of functional change when it has been achieved following cognitive remediation.[6,8,10] Therefore, the relationship between cognitive function and social function is not always a direct one and may depend on the way in which cognitive improvement occurs.

A greater understanding of the links between cognitive and functional change is needed to identify appropriate cognitive targets for treatment. Treatment studies to date have rarely investigated the impact of improved cognitive function on social functioning, the moderating role of treatment on these links, or baseline associations between cognitive and social functions, which may help to elucidate whether links are direct or indirect.

Another problem has been the use of cognitive measures which are difficult to interpret. It is now well

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established that both executive and memory functions are fractionable and may be differentially impaired (and thus have differential impacts on functioning).[11,12] For example, one of the most widely accepted models of executive functioning[13] postulates an executive supervisory attentional system (SAS), which operates over at least 3 stages and carries out a wide range of cognitive functions. It is said to be the higher order component of a 2-tiered information-processing system which modulates the selection of sequences of responses (or schemas) which are then carried out by a lower level component, the contention scheduling system. The SAS operates over at least 3 stages: (1) construction of a temporary new "schema" or subroutine, (2) maintaining the schema in working memory and implementing it, and (3) monitoring and subsequently rejecting or modifying the temporary schema when necessary and inhibiting automatic responses which are not consistent with the temporary schema or current goal.

Treatment studies frequently treat executive and memory domains as unitary functions or have used measures which are too coarse to allow specific impaired processes to be identified.[14] This leads not only to interpretation problems but also potentially to misleading results. For example, Reeder and colleagues[6] showed that change in a factor which loaded highly on perseverative errors on the Wisconsin Card Sorting Test (WCST), but not in a response inhibition factor, predicted functional change. Combining these 2 executive scores may have resulted in very different apparent associations emerging. Studies which fail to discriminate between different component cognitive processes are unlikely to identify the possibly varying links between these component cognitive functions and social behavior.

This study aims systematically to explore the links between well-specified executive and memory functions and social behavior in treatment. The cognitive focus was on executive functioning and memory specifically because they are very frequently impaired in schizophrenia and are the cognitive functions which have been perhaps most consistently found to be associated with social functioning.[1,2] Cleaner cognitive measures were identified using a factor analysis of executive and working memory measures and a priori groupings of assessments of long-term memory. Different methods were used for the different cognitive variables because distinctions between different aspects of long-term memory are well established, and tests tend to have high construct validity. However, differential executive and working memory processes are not well established, and there is considerable overlap between component processes and the tests purported to measure them. Therefore, a more exploratory technique was used to identify component executive and memory processes. The study aimed to investigate (1) the baseline associations between executive/memory function and social functioning, (2) the impact of cognitive changes on social functioning, and (3) the moderating role of cognitive remediation.

Materials and Methods

Ethical approval for the study was given by the Institute of Psychiatry Research Ethics Committee.

Participants

Participants were referred by Community Mental Health Teams in the South London and Maudsley NHS Trust. Participants fulfilled the following criteria, which were established using case notes, reports from mental health workers, and interviews with participants:

Inclusion Criteria

(i) A *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*), diagnosis of schizophrenia (established from case notes and informal interviews with consultant psychiatrists and participants).
(ii) Aged 17–66 years.
(iii) Evidence of executive or memory impairment/inefficiency (a score of more than 1 standard deviation [SD] below the normative mean on the Rivermead Behavioral Memory Test [RBMT],[15] the Hayling Test,[16] or the WCST[17]). A discrepancy from the normal population of more than 1 SD can be considered to suggest "a trend toward a significant deficit."[18] Only participants with cognitive inefficiency or impairment were included because the aim was to show differential cognitive improvements for the CRT group, and it seemed unlikely or unnecessary for normal cognition to be improved upon.

Exclusion Criteria

(i) Current plans to change medication,
(ii) evidence of a premorbid learning disability/a current IQ of less than 70,
(iii) substance abuse, as defined by *DSM-IV*, and
(iv) evidence of head injury or organic disorder.

Procedure

All participants gave informed written consent ($N = 85$). All assessments were carried out by psychology graduates, with the exception of the Positive and Negative Syndrome Scale (PANSS), which was conducted by the study psychiatrist. The psychiatrist was blind to treatment assignment at both time points, but the psychology graduates were blind at the first but not at the second assessment (because they spent considerable time with patients who gave frequent clues about whether or not they had received CRT). Sociodemographic data were collected from case notes, mental health workers, carers, and participants.

All participants were assessed on the measures below and then were randomly assigned to receive CRT plus treatment-as-usual (TAU) (n = 43) or TAU (n = 42). Participants were reassessed posttherapy (CRT) or 3 months postbaseline (TAU).

This was not an intention-to-treat analysis because the goal was not to investigate treatment efficacy, and so, only participants who had complete data (due to statistical constraints) were included.

Participants had a mean age of 39.19 years (SD = 10.37) and had been in full-time education for a mean of 11.48 years (SD = 2.14). In all, 73% were men. In all, 28% had been in contact with psychiatric services for less than 5 years and 52% for more than 10 years. In all, 48% were white, 84% had never been married, and only 4% were in paid employment. A total of 31% were inpatients, and only 21% were in independent accommodation without support from relatives or staff.

The mean total score on the PANSS was 59.96 (SD = 15.81), the mean sum of the positive scale was 13.17 (SD = 5.24), and the mean sum of the negative scale was 17.65 (SD = 7.29).

All but 3 participants were prescribed antipsychotic medication. A total of 74% were prescribed atypical antipsychotics, and 28% were prescribed typical antipsychotics. A total of 20% were prescribed anticholinergic medication.

Means and SDs of baseline cognitive test scores for the complete sample (N = 85) are reported in table 1.

Table 1. Cognitive and Social Functioning Scores for the Complete Sample (N = 85)

Variable	Mean (SD)
National Adult Reading Test	92.46 (13.09)
RBMT	
Immediate recall	3.61 (2.32)
Delayed recall	2.67 (2.01)
Logical Memory	
Immediate recall	12.69 (6.64)
Delayed recall	7.91 (6.31)
Doors Test	13.32 (4.31)
BVRT	4.19 (2.35)
Letter-number sequencing	6.71 (3.08)
Digit Span	14.64 (3.92)
Verbal fluency	27.37 (10.35)
Hayling Test	20.66 (19.13)
WCST	39.01 (25.58)
Response inhibition test	1259.94 (798.55)
Stroop task	71.94 (25.48)
Rule Shift	3.01 (3.52)
Key Search	8.60 (5.83)
Zoo Map	5.46 (8.77)
Six Elements	3.64 (1.69)
SBS	12.37 (9.86)

Note: RBMT, Rivermead Behavioral Memory Test; BVRT, Benton Visual Retention Test; WCST, Wisconsin Card Sorting Test; SBS, Social Behavior Schedule.

Measures

The following measures were administered:

Premorbid IQ

(i) National Adult Reading Test[19]—estimated premorbid full-scale IQ.

Executive Functioning and Working Memory

(i) WCST—number of perseverative errors.

(ii) Hayling Test—part 2 error score (weighted according to the extent to which the incorrect response is related to the preceding sentence).

This consists of 2 parts. In the first section, the participant provides strongly primed words to complete 15 sentences as quickly as possible (eg, "He posted the letter without a ...."; "stamp"). In the second section, the participant provides an alternative word to complete a different set of 15 sentences that does not make sense in the context (eg, "The captain wanted to stay with the sinking ...."; "banana").

(iii) Stroop Neuropsychological Screening Test[20]—total correct in 120 seconds on the color-word task minus total correct in 120 s on the color task.

(iv) Verbal fluency: Controlled Oral Word Association Test[21]—total correct.

(v) Spatial response inhibition test[22]—median time for the 4 button-incompatible response minus median time for the 4 button-compatible response.

This test is in 3 parts. For the first part, the participant is presented with a single red light with a button just below it. The light is turned on at random intervals by the tester and must be turned off as quickly as possible by the participant using the button (40 trials). For the second part, 4 red lights (arranged in a circle) with 4 adjacent buttons (forming an inner circle) are presented to the participant. Participants must turn off randomly illuminated lights using the adjacent button (40 trials). This part sets up a prepotent response. Finally, randomly illuminated lights must be extinguished using the button one position away in a clockwise direction from the light (80 trials)—median reaction time (part 3) minus median reaction time (part 1)

(vi) Behavioral Assessment for the Dysexecutive Syndrome[23]
  (i) Rule Shift—total number of errors trial 2.
    This is a task of response inhibition. In the first part, participants say "yes" or "no" according to whether cards are red or black (the prepotent response). In the second part, the rule has changed so that the participant must respond "yes" or "no" depending on the color of the previous card.
  (ii) Key Search—total raw score.
    This is a measure of strategy use in which participants are presented with a blank square representing a field. Participants must draw the route they would take to search the field for lost keys.
  (iii) Zoo Map—total raw score.
    This is a test of planning, requiring participants to map out their route to visit 6 of possible 12 designated locations around a zoo according to a set of simple instructions.
  (iv) Modified Six Elements—total raw score.
    This is a test of planning in which participants carry out dictation, arithmetic, and picture-naming tasks in 10 min. No 2 parts of the same task should be completed consecutively.

Digit Span: *The Wechsler Adult Intelligence Scale. Third edition, UK version (WAIS-III-UK)*[24]—total raw score.

Letter-number sequencing: *WAIS-III-UK*[25]—total raw score.

Long-term Memory

(i) RBMT—(1) story immediate-recall total score and (2) story delayed-recall total score.

(ii) Logical Memory Test: Wechsler Memory Scale: Revised[26]—(1) immediate-recall total score and (2) delayed-recall total score.

(iii) Benton Visual Retention Test (BVRT)[27]: Form C, Administration B—total score.
  Participants must reproduce 10 simple geometric designs in turn from memory.

(v) Doors Test[28]—total raw score.
  This is a visual multiple-choice recognition test in which stimuli are pictures of doors.

Social Functioning

(i) Social Behavior Schedule (SBS)[29]—total score.
  This assessment of social functioning over the last month is a semistructured interview conducted with an informant who knows the participant well (eg, a carer or keyworker). High scores indicate high levels of problem behaviors.

Symptoms

Structured Clinical Interview for the PANSS[30]—total score, positive scale total, negative scale total.

Therapy

This was a one-to-one psychological therapy consisting of 40-hour-long sessions taking place on at least 3 days per week.[31] Its primary cognitive targets are attention, memory, and executive function. All participants follow a similar therapeutic protocol which uses training techniques such as scaffolding and errorless learning to teach information-processing strategies. The therapy is individually tailored and consists of repetitive but increasingly demanding pencil and paper tasks. Strategy-use, well-organized behavior, and accurate performance are frequently positively reinforced with praise.

Statistical Analyses

Where necessary, scores were multiplied by -1 so that high scores always indicated good performance.

An exploratory factor analysis including the executive and working memory measures used principal components analysis and inspection of the scree plot to determine the number of factors. Factors were then extracted using principal axis factoring with direct oblimin rotation because it was assumed that executive factors would be correlated. Delta was set to -0.7. This was the lowest value for which the rotation converged in 25 iterations; higher values resulted in very high correlations between 2 of the factors (verbal working memory and response inhibition).

Factor scores were calculated using Bartlett's approach in order to achieve scores which were correlated similarly to the correlations between factors.[32] Factor scores at both time points were calculated using the baseline factor solution.

Two composite long-term memory scores were created: "verbal long-term memory" (all RBMT and Logical Memory story recall scores) and "visuo-spatial long-term memory" (BVRT and Doors scores). Baseline z scores were calculated for each constituent variable, and the means of the component z scores were used to form the composite scores. Memory scores at time 2 were also standardized using the baseline sample means and SDs.

Pearsons correlations were conducted to investigate the baseline associations between SBS total scores and the 5 cognitive scores.

To test for between-group differences in change over time on the cognitive and social functioning variables, analyses of covariance (ANCOVAs) were conducted with time 2 scores as the dependent variable and baseline scores as a covariate. The fixed factor was treatment group. This type of analysis is more powerful than alternatives

Table 2. Factor Pattern Matrix

	Factor		
Variables	Verbal Working Memory	Response Inhibition	Schema Generation
Six Elements	**.564**	.158	.165
Digit Span	**.753**	−.042	−.002
Verbal fluency	**.494**	.258	.047
Hayling	**.352**	.177	.199
Letter-number sequencing	**.617**	.301	−.105
Rule Shift	.213	**.594**	.044
Stroop	.083	**.655**	−.124
Response inhibition	.027	**.714**	.053
Zoo Map	.125	**.594**	.022
Key Search	−.052	**.438**	.198
WCST	.027	.000	**.792**

Note: WCST, Wisconsin Card Sorting Test.

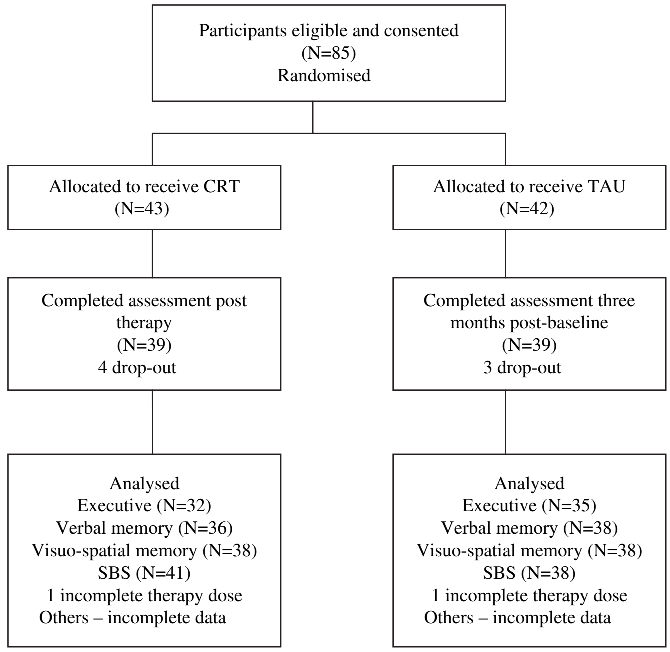

Fig. 1. Flow Diagram of CONSORT Statement.

such as repeated-measures analyses or using change scores.[33,34]

Cognitive and social functioning changes over time for the complete sample were assessed using paired-samples *t* tests.

To test whether cognitive change predicted change in social functioning, ANCOVAs were conducted with time 2 SBS scores as the dependent variable and baseline SBS scores and a cognitive change score (time 2 − time 1) as covariates. The fixed factor was treatment group. An interaction between the fixed factor and the cognitive change score was included in each analysis to test the hypothesis that CRT moderates the relationship between cognitive and social functioning change. If the interaction term was not significant, it was removed and the analysis was rerun.

Results

Exploratory Factor Analysis

Complete data for inclusion in the factor analysis were available for 79 participants. Three factors were extracted with initial eigenvalues of 4.68, 1.11, and 1.04 and which accounted for 49% of the variance. The factor pattern matrix suggested that a simple structure had been achieved.[35] This is shown in table 2. The factor pattern matrix was used to interpret the factors, and the interpretation was checked against the pattern structure matrix.[36,37]

The highest correlation was between the verbal working memory and response inhibition factor (r = .536). The correlation between "schema generation" and response inhibition was .278 and between schema generation and verbal working memory was .196.

Longitudinal Analyses

The CONSORT diagram is shown in figure 1.

The treatment groups were equivalent on all cognitive, social functioning, and symptom measures at baseline. Medication was also similar for the 2 groups in terms of the types and dosages prescribed.

Baseline Associations The results of the Pearsons correlations are shown in table 3.

Changes in Cognition and Social Functioning ANCOVAs showed that there was significantly greater improvement in the CRT group relative to controls in the verbal working memory factor (F = 4.31, df = 1,64, P = .04). There was no difference between the 2 groups in change in schema generation (F = 0.05, df = 1,64, P = .82), response inhibition (F = 0.38, df = 1,64, P = .54), verbal long-term memory (F = 0.54, df = 1,71, P = .46), or visuo-spatial long-term memory (F = 0.32, df = 1,73, P = .57). However, mean cognitive scores at time 2, adjusting for baseline performance were consistently positive which suggests that cognitive performance improved over time for the 2 groups. These scores are shown in table 4.

To test whether this improvement was significant, paired-sample *t* tests were conducted, comparing time 1 and time 2 performance for the complete sample. There was a significant improvement in verbal working memory (t = −3.24, df = 66, $P < .01$), verbal long-term memory (t = −3.57, df = 73, $P < .01$), and visuo-spatial long-term

Table 3. Pearsons Correlations Between Social Functioning and Cognitive Functions

	Verbal Working Memory	Response Inhibition	Schema Generation	Verbal Long-term Memory	Visuo-Spatial Long-term Memory
Social behavior schedule	r = **−.328** n = **78** P = **.003**	r = **−.333** n = **78** P = **.003**	r = −.132 n = 78 P = .249	r = **−.328** n = **81** P = **.003**	r = **−.290** n = **83** P = **.008**

memory ($t = -2.64$, $df = 75$, $P = .01$) but not in response inhibition ($t = -1.59$, $df = 66$, $P = .12$) or schema generation ($t = -.60$, $df = 66$, $P = .55$). However, there was considerable variability within the sample with respect to the amount and direction of change that occurred. To demonstrate this, change scores were calculated by subtracting baseline from time 2 cognitive performance to show the range of change that occurred for participants (0 = no change, 1 = improvement by 1 SD, and −1 = decrement in performance by 1 SD). These are shown in table 5.

There was no significant difference between the 2 groups in change in social functioning (F = 0.09, df = 1,76, $P = .77$). However, there was a significant improvement in social functioning for the complete sample ($t = 2.05$, $df = 78$, $P = .04$).

Links Between Changes in Cognition and Social Functioning There were no significant interactions between group and any of the cognitive scores. When the interaction term was removed, improvement in schema generation (F = 3.95, df = 1,62, $P = .05$), but in none of the other cognitive scores, was significantly predictive of improvement in SBS scores (verbal working memory: F = 0.05, df = 1,62, $P = .83$; response inhibition: F = 0.22, df = 1,62, $P = .64$; verbal long-term memory: F = 0.30, df = 1,69, $P = .58$; and visuo-spatial long-term memory: F = 0.73, df = 1,71, $P = .40$).

Discussion

This was a demographically representative sample of an inner city schizophrenic population, characterized by a reasonably chronic course, a high level of disability, and moderately severe positive and negative symptoms.[38–40]

Interpretation of Executive and Working Memory Factors

This was based on the model of executive functioning of Shallice and Burgess,[13] which was described in the "Introduction" section. The first factor verbal working memory comprised high loadings on tests which rely upon the online storage, retrieval, and use of verbal information to guide output: the second stage of processing in Shallice and Burgess' model.[13]

The second factor response inhibition loaded on tests which assess the ability to inhibit a primed response set and generally to shift to an alternative, given response set: the third stage in the executive model.

The WCST (which has the highest loading on the third factor) as well as the Hayling, Key Search, and the Six Elements Tests (which load modestly on the third factor) also require the participant to inhibit a prepotent response. However, the participant must then generate, implement, and maintain an alternative response set, which is not specified by the instructions (the first stage of SAS functioning).

While this is a relatively small sample for the number of variables to be included in the factor analysis, the results closely correspond to those of Reeder et al,[6] who identified 3 similar factors in an earlier factor analysis of executive measures.

Associations Between Executive Function/Memory and Social Function

At baseline, good social behavior was significantly associated with good verbal working memory, response inhibition, verbal long-term memory, and visuo-spatial long-term memory measures. The only cognitive factor which failed to emerge as a significant predictor of functioning was schema generation which is perhaps surprising given the high loading of the WCST. The WCST has been found to be associated with social functioning in

Table 4. Mean Cognitive Scores at Time 2, Adjusting for Baseline Performance

	Verbal Working Memory	Response Inhibition	Schema Generation	Verbal Long-term Memory	Visuo-Spatial Long-term Memory
CRT mean (SE)	.57 (0.12)	.13 (0.11)	.10 (0.19)	.43 (0.13)	.24 (0.09)
TAU mean (SE)	.22 (0.12)	.22 (0.11)	.04 (0.18)	.30 (0.12)	.16 (0.09)

Note: CRT, cognitive remediation therapy; TAU, treatment-as-usual.

Table 5. Cognitive Change Scores

	Verbal Working Memory	Response Inhibition	Schema Generation	Verbal Long-term Memory	Visuo-Spatial Long-term Memory
CRT					
Mean (SD)	0.50 (0.92)	0.13 (0.78)	0.11 (1.25)	0.41 (0.68)	0.21 (0.51)
Range	−1.25 to 2.68	−1.86 to 1.75	−3.53 to 3.10	−1.27 (1.98)	−0.91 to 1.68
TAU					
Mean (SD)	0.13 (0.56)	0.15 (0.65)	0.07 (1.20)	0.24 (0.87)	0.14 (0.63)
Range	−1.19 to 1.21	−1.69 (1.70)	−3.66 to 2.20	−1.07 to 2.63	−1.51 to 1.24

Note: CRT, cognitive remediation therapy; TAU, treatment-as-usual.

a number of other studies, but these have tended to use either more specific measures of social problem solving[41,42] or global measures of functioning.[43,44] In other studies which have used more closely comparable measures of social behavior, WCST performance has not been found to significantly predict social functioning.[45,46]

If there is a direct relationship between cognition and social functioning, then we would predict that improvements in the cognitive functions significantly associated with social functioning at baseline would lead to improved social functioning. While there was indeed improvement in the cognitive measures correlated with initial social functioning (ie, working and long-term memory measures, although not response inhibition), none of these changes predicted improvement in social behavior. By contrast, the schema generation factor was not associated with social functioning at baseline, but improved schema generation performance was significantly associated with improved social functioning. Thus, there is no evidence for a simple direct relationship between them; baseline correlations may not therefore provide straightforward targets for intervention and may fail to highlight potentially fruitful targets.

These results were consistent with findings from studies by Spaulding and colleagues[8] and Wykes and colleagues[7] which showed that improvement in a card sorting test and composite measure of cognitive flexibility (including WCST performance), respectively, was predictive of improved social functioning, regardless of whether or not participants had received cognitive remediation. Reeder and colleagues[6] also showed that improvement in an executive factor (loading highly on the WCST) was predictive of SBS improvement, but this was true only for participants who had received CRT. The study by Spaulding et al[8] also showed that improved verbal long-term memory differentially predicted improved social functioning for only the CRT group. The results from the current study showed no moderating effect of CRT. Differences with Spaulding's study are possibly explicable by the use of a different measure of social function which had a greater emphasis on problem solving than the current measure. The discrepancy with the study of Reeder et al[6] may result from their smaller sample size which perhaps offered insufficient power to detect significant associations between the executive factor and social functioning within the control group who showed little cognitive improvement.

A specific improvement in schema generation is emerging with some consistency across studies as being associated with improved social functioning. While we cannot be sure of the direction of causation in this relationship from the results of this study, generating a hypothesis to explain the association (which can be tested in subsequent studies) may be helpful in establishing the direction of causation. We have argued elsewhere that there are 2 types of actions: routine and nonroutine actions.[3] Routine actions are those which are carried out in the same way regardless of context and rely upon well-specified cognitive processes or "schemas" (sometimes referred to as "scripts" or "mental models"). Schemas are generic knowledge structures or templates that are stored within long-term memory and are the means by which mental representations are organized.[47,48] For example, a "writing schema" will include a writer, implements, a surface on which the writing occurs, and the writing itself, but the particular nature of each of these elements is not specified by the schema. A person having a writing schema is able to use this generic information to make sense of a writing situation even if some of the elements of the schema are omitted. The schema provides the slots which can be filled either by perceptions or which can be extrapolated or inferred from the context. Schemas can also prime certain actions and set up a context for their use.

Routine actions, which are fully specified by an existing schema, are well rehearsed and consequently carried out with little effort or reflection (although some executive processing may be required). Cognitive improvements are likely to have a limited impact on routine social functioning because schemas already specify in detail how the behavior should be carried out. Therefore, inefficient or ineffective actions may continue to be carried out in the same way, despite a greater capacity to act more effectively. In order for improvements to be made in routine social behaviors, the person must reject their existing schema and create a new more efficient temporary schema. Therefore, routine social functioning may improve if a person becomes more confident or more efficient in generating new schemas.

Nonroutine actions are those for which the person does not have an existing schema. He or she must therefore create a new temporary schema to guide his or her behavior. Therefore, nonroutine social behavior will also improve if the ability to generate new efficient schemas improves.

Improvements in cognitive skills other than schema generation are also likely to benefit social functioning as they become incorporated into new schemas. This change is likely to be relatively slow for routine actions, which are only gradually updated as the person becomes dissatisfied with existing schemas. However, for nonroutine actions (which rely on the development of a new schema), new skills can be incorporated immediately. This suggests that the cognitive targets for treatment may differ depending on the timescale and whether or not participants have opportunities to engage in nonroutine actions. For short-term functional gains, schema generation may be the most appropriate cognitive target. However, longer term functioning improvements, particularly, for people who are consistently faced with nonroutine activities are likely to result from a wider range of cognitive gains.

This model is consistent with the results of the current study which shows that improved short-term social functioning was associated with improvements in schema generation. Furthermore, longer term results from the same trial (T. Wykes, C. Reeder, S. Landau, B. Everitt, M. Knapp, and A. Patel, unpublished data, 2006) show that improved memory is associated with improved SBS functioning 6 months after CRT had ended. Thus, as predicted, over time, actions may be gradually modified to include new cognitive skills which then might be associated with social functioning improvements. Also supportive of the model is evidence of substantial improvements in work performance following CRT for people beginning work after a period of unemployment.[10,49] We have hypothesized that nonroutine activities (such as those required in a new job) will benefit from a wide range of cognitive improvements, even in the short term, and so a burst of new nonroutine activity (such as in rehabilitation programs) is likely to improve rapidly following cognitive improvements, as long as schema generation is relatively efficient.

In summary, the relationships between cognition and social functioning do not appear to be simple or direct, and thus, cross-sectional associations between cognition and social function may not always offer the best means to identify good targets for intervention. The ability to generate new effective schemas may warrant further research because it appears to have a consistent benefit on social functioning. Future research needs to address issues of timing in improvements following treatment, as well as the opportunity for cognitive gains to be translated into improvements in everyday functioning. Furthermore, a greater understanding of the links between specific cognitive and functional changes is required in order to develop a theoretical framework with which to guide the development of treatments for cognitive function in schizophrenia.

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