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Cognitive remediation and occupational outcome in schizophrenia spectrum disorders: A 2 year follow-up study

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ABSTRACT

Neurocognitive impairment is prominent in schizophrenia and a significant predictor of poor occupational outcomes. Vocational rehabilitation (VR) is frequently implemented to counteract high unemployment rates. Individuals with schizophrenia however face numerous challenges such as neurocognitive impairments and psychotic symptoms. Hence, augmenting VR to address illness-related factors may optimize occupational outcomes. The aim of this study was to examine the effects of Cognitive Remediation (CR) combined with VR(CR + VR) compared to techniques from Cognitive Behavioral Therapy (CBT) combined with VR(CBT + VR) on neurocognition and occupational functioning over a 2 year period. A total of 131participants underwent assessment with the MATRICS Consensus Cognitive Battery (MCCB) at baseline, post treatment (after 10 months) and follow-up (2 years after randomization). Occupational status and number of hours worked were recorded at all assessment points. Both groups improved on several neurocognitive domains. All improvements were however in favor of the CR group. There was a significant increase in number of participants working and hours worked in both groups throughout the project period, with no between-group differences. Number of hours worked at follow-up was predicted by change in Working Memory and the Composite Score in the CR group. CR-augmented VR improved several domains, particularly Verbal Learning and Working Memory, which were central in the CR program. The combination of VR and CR or CBT thus enabled a significant proportion of participants to attain and maintain work.

1. Introduction

Neurocognitive deficits are prominent in schizophrenia (August et al., 2012; Green et al., 2004; Reichenberg et al., 2009) and significantly related to functional outcome (Bowie and Harvey, 2005; Green, 2006; Keefe, 2014; McGurk and Mueser, 2006; Shamsi et al., 2011; Strassnig et al., 2015). Neurocognitive impairment contributes substantially to low occupational attainment and poor occupational outcomes (Christensen and Stergaard, 2007; Kukla et al., 2012; Lystad et al., 2015; Strassnig et al., 2015; Vargas et al., 2014) and is an important predictor of poor engagement in vocational rehabilitation (VR) (O'Connor et al., 2011).

In addition to financial benefits, employment is associated with improved self-esteem, quality of life and lowered relapse rates in schizophrenia (Bond et al., 2001; Bryson et al., 2002; Bush et al., 2009; Lieberman et al., 2008; McGurk and Mueser, 2004). Although work is a commonly sought goal, considerable research has shown that employment rates are consistently low, estimates ranging from 10% to 25% (Bond, 2004; Evensen et al., 2015; Marwaha and Johnson, 2004; Tandberg et al., 2011).

As vocational rehabilitation gains momentum in clinical guidelines, the implementation of programs including Supported Employment (SE)/Individual Placement and Support (IPS) has increased accordingly to help individuals with schizophrenia reach their work goals. However, despite superior competitive employment outcomes in SE/IPS studies (Bond et al., 2012; Marshall et al., 2014), this group still faces numerous occupational challenges such as unwanted job discontinuations and work performance difficulties. These may be caused by illness-related barriers, including neurocognitive functioning (Allott et al., 2013;

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Bond et al., 2012; Marshall et al., 2014). Hence, augmenting vocational programs in order to address illness-related barriers and optimize occupational outcomes are of interest (Khare et al., 2016).

The strong relationship between neurocognition and occupational outcome underlines the importance of targeting neurocognitive dysfunctions through psychosocial interventions such as cognitive remediation (CR) as a means to improve occupational functioning. Recent meta-analyses show small to moderate effects of CR on neurocognition and beneficial effects on symptoms and psychosocial functioning, including social skills and employment when integrated with psychiatric rehabilitation (McGurk et al., 2007; Wykes et al., 2011). The combination of VR with CR appears to maximize benefits of CR, allowing participants to apply enhanced neurocognitive skills in real-world settings (McGurk et al., 2007).

Individuals with schizophrenia also face challenges such as psychotic symptoms, comorbid disorders, stigma, low expectations and social impairments that interfere with occupational functioning (Buckley et al., 2009; Milev et al., 2005; Morrison, 2009). Combined, these factors may translate into beliefs of own incompetence and fear of occupational failure, in turn elevating stress levels, lowering problem-solving capabilities and possibly resulting in actual limited occupational function. Negative expectations toward self-efficacy and self-defeating beliefs are strong predictors of occupational outcomes (Davis et al., 2004; Lysaker et al., 2009), thus addressing these beliefs as they appear in a work setting suggests adapting general CBT principles to 'vocational CBT. There is strong support for CBT improving symptoms and social relations (Rector and Beck, 2001; Tarrier and Wykes, 2004). More recently, CBT programs designed to enhance occupational functioning have been developed (Kukla et al., 2014; Lecomte et al., 2014). Although evidence is still scant regarding CBT adjunct to VR, results are promising (Davis et al., 2008; Lecomte et al., 2014; Lysaker et al., 2009).

The aim of this study was to examine the effects of a CR augmented VR program, the Job Management Program (JUMP), on neurocognition and occupational functioning in participants with schizophrenia spectrum disorders. The comparison group received CBT augmented VR. Specifically, we evaluated the effects of CR on neurocognitive and occupational outcomes over a two year period

2. Material and method

2.1. JUMP

JUMP is a multisite hybrid VR program for adults with psychotic disorders in Norway. JUMP is a collaborative effort between health and welfare services with the overall goal of enhancing occupational outcomes for persons with psychosis. Participants were offered a 10 month extensive program consisting of competitive or sheltered work, close collaboration between psychiatric and vocational services, employers and employment specialists in addition to either CR *or* CBT. CR and CBT were carried out by employment specialists based in sheltered workshops. Throughout the project, employment specialists received weekly supervision by an experienced mental health professional. In SE/IPS programs, competitive employment is the main goal. Competitive employment was defined as part- or full-time work in a position that is open to anyone and wages were paid by the employer.

Sheltered employment refers to work in a sheltered workshop. Tasks may be similar to those in competitive positions; the pay is however different, as sheltered work is funded by the Norwegian Labor and Welfare Services through so-called work assessment allowance or disability pensions. It is important to note that sheltered work did not represent pre-vocational training in which participants underwent preparation (preparing for job interview, how to write a successful CV etc.), but rather work with actual demands in a sheltered environment.

SE/VR services in the Nordic countries routinely offer sheltered work in a train and place tradition (Hagen et al., 2011). Vocational training is thus offered in sheltered workshops if competitive work is not possible. Work placement is work in a competitive setting financed by the Norwegian Labor and Welfare Administration through work assessment allowance or disability benefits. Work demands are however equal to those in competitive employment. JUMP was carried out within this tradition; consequently, all types of employment were considered a success.

JUMP consists of the following components:

2.2. Interventions

2.2.1. Cognitive remediation

Employment specialists received information about neurocognitive impairment in psychotic disorders. Furthermore, they were taught basic principles of CR, use of computer software, strategies to enhance motivation and performance, and transfer of knowledge and skills acquired through training to the work setting. The JUMP CR program is similar to the Thinking Skills for Work program (McGurk et al., 2005; McGurk et al., 2015). Training lasted 40 h. The program included the following elements: Feedback from neurocognitive assessment, setting up personal goals for the training, psychoeducation about cognitive impairment, and two hours weekly of computer-based training with focus on transfer between training and work. The computer programs targeted attention/vigilance, working memory, visual and verbal memory, executive functioning and processing speed. The tasks originated from four different programs: COGPACK (Marker Software), Vision Builder (Haraldseth Software), Brain Fitness and InSight (Posit Science). The computerized training program contained elements based on a combination of feed-forward bottom up and top-down processes. Participants carried out repetitive drill-and-practice tasks to enhance and automatize neurocognitive processing (bottom-up) and when tasks allowed, strategy use was implemented (top-down).

2.2.2. Cognitive behavioral therapy techniques

Employment specialists received training in basic methods of CBT, focusing on maladaptive patterns of thinking contributing to, or arising from work related difficulties. Training lasted 40 h. The CBT intervention was based on principles of simple behavioral activation concepts such as activity schedule and gradual task assignments as well as addressing of maladaptive schema underlying beliefs with regard to the occupational setting (Co-workers, supervisors etc.). CBT was carried out by employment specialists in individual sessions with participants twice a week. That is, employment specialists in the CBT intervention worked with participants in the attempt to alter cognitive biases related to work by addressing content of thought and style of thinking in terms of recognizing, changing and coping with underlying thinking patterns possibly limiting occupational success. Social relationships were addressed through focus on work environment and close cooperation with the immediate supervisor; for example how the workplace is organized, working conditions, rehearsal of social situations arising in the workplace etc. The CBT intervention in the JUMP study did not focus on psychotic symptoms but concentrated on work related negative thoughts and beliefs. Frequently used techniques were cognitive restructuring, motivational interviewing, graded exposure and homework.

The group receiving CBT augmented VR serves as a comparison group in the current paper.

2.2.3. Vocational rehabilitation

Employment specialists focused rapid job placement in positions matched to participants preferences with ongoing job support. Competitive employment was the goal, but vocational training was offered in sheltered workshops if this was not possible.

Participants were assessed at baseline, post treatment approximately 10 months after baseline and 2 years after randomization (follow-up). CBT and CR were discontinued at post treatment.

The study was approved by the Regional Committee of Medical Research Ethics and the Norwegian Data Protection Authority. ClinicalTrials.gov Identifier: NCT01139502.

2.3. Participants

Participants were referred from psychiatric and vocational services. Self-referral was also possible. All participants provided written informed consent. Exclusion criteria were head injury with loss of consciousness, neurological disorder, IQ below 70, medical condition interfering with brain function and age outside the range 18–65. Individuals scoring 3 or more on violent behavior, severe alcohol and/or drug dependence and suicidal ideation as measured with the Health of the Nation Outcome Scales (Wing et al., 1998) were also excluded. Participants were required to understand and speak Norwegian to assure valid neurocognitive test performance.

A total of 131participants meeting the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (APA, 1994) criteria for a broad schizophrenia spectrum disorder were included, 68 and 63 respectively allocated to the CBT and CR interventions (Fig. 1).

2.4. Assessments

2.4.1. Clinical assessments

M.I.N.I. PLUS (Sheehan et al., 1998) was used for diagnostic evaluation. Levels of psychotic symptoms were evaluated using the Structural Clinical Interview of the Positive and Negative Syndrome Scale (SCI-PANSS) (Kay et al., 1987). Demographic data were also recorded.

2.4.2. Neurocognitive assessment

Current IQ was estimated at baseline with the Wechsler Abbreviated Scale of Intelligence, two subtests form (WASI, 2007) including Vocabulary and Matrix Reasoning.

Neurocognition was assessed with the nine subtests from the MATRICS Consensus Cognitive Battery (MCCB) (excluding the measure of social cognition) assessing six domains; *Speed of processing*, *Attention/Vigilance*, *Working memory*, *Verbal learning*, *Visual learning and Reasoning and problem solving*. A modified MCCB neurocognitive composite score was calculated using the mean of the nine demographically corrected domain T-scores.

2.4.3. Functional assessment

Occupational status, categorized as working (sheltered, competitive or work placement) versus not working and number of hours worked per week at follow-up were recorded by employment specialists.

2.5. Statistical analyses

IBM SPSS Statistics for Windows, Version 20.0 (2011) was used for all analyses. MCCB raw scores were converted to T-scores based on US norms (Kern et al., 2008). All tests were two-tailed. Levels of significance were set at $p = 0.05$. In order to examine group differences, baseline comparisons were conducted with Students t-tests or Chi-square tests.

Linear mixed models (LMM) for repeated measures were applied to analyze changes in neurocognitive variables by treatment group, using intercepts as random effects.

Occupational status at the three assessment points was described and between-group differences in number of participants working at baseline, post treatment and follow-up were analyzed with a Chi-square test. Multiple logistic regression analyses were conducted to explore group differences in occupational status and multiple hierarchical regression analyses to examine predictors of hours worked. Exploratory analyses were conducted to examine whether neurocognitive change predicted type of work (sheltered versus competitive).

3. Results

3.1. Baseline analyses

There were no between-group differences at baseline on demographic, clinical, neurocognitive or medication variables (Table 1) except for gender.

3.2. Neurocognition

Improvements on several neurocognitive domains for both groups were found. Estimated marginal means derived from the LMM are presented in Fig. 2 (including 95% Confidence Intervals) and effect sizes for both interventions in Table 2 (Cohen's d). The intervention-by-time interaction was significant for working memory ($F = 4.81$, $df = 2211$, $p = 0.009$, $\eta_p^2 = 0.12$) and the composite score ($F = 3.68$, $df = 2, 178$,

Fig. 1. Subject flow in the JUMP study; referrals, baseline and follow-up assessments (NP = neuropsychological assessment).

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Table 1
Demographic, clinical, neurocognitive and medication characteristics of the JUMP participants by treatment group.

	CBT ($N = 68$)	CR ($N = 63$)	Test statistics (df)[a]	Group comparison (p)
Diagnosis			X^2 (8, $n = 131$) $= 0.59$	*ns*
Schizophrenia	89.6%	87.2%		
Schizoaffective disorder	5.9%	9.6%		
Psychosis NOS	1.5%	1.6%		
Delusional disorder	2.9%	1.6%		
Age, mean (SD)	33.2 (8.2)	32.2 (7.7)	t (129) $= 0.75$	*ns*
Gender, male (%)	42 (61.8%)	50 (79.4%)	X^2 (1, $n = 131$) $= 4.85$	0.03
Education, mean (SD)	12.0 (2.6)	11.6 (2.2)	t (129) $= 1.05$	*ns*
IQ, mean (SD)[b]	102.3 (13.2)	102.4 (13.1)	t (129) $= -0.05$	*ns*
Units of DDD[c] main antipsychotic, mean (SD)	1.6 (3.0)	1.4 (1.5)	t (129) $= 0.41$	*ns*
Duration of illness, mean years (DOI) (SD)	7.9 (7.0)	5.9 (5.5)	t (124) $= 1.76$	*ns*
SCI-PANSS				
Positive, mean (SD)	12.8 (4.6)	14.0 (4.5)	t (127) $= -1.49$	*ns*
Negative, mean (SD)	16.7 (5.8)	15.9 (5.6)	t (126) $= 0.79$	*ns*
General, mean (SD)	29.3 (8.9)	30.2 (7.6)	t (128) $= -0.57$	*ns*
Total, mean (SD)	58.8 (16.5)	59.8 (14.2)	t (125) $= -0.36$	*ns*
Previous competitive employment (lifetime)				
Previously employed	86.8%	82.5%	χ^2 (1, $n = 131$) $= 0.45$	*ns*
Months part time, mean(SD)	18 (39.2)	15.4 (31.2)	χ^2 (27, $n = 131$) $= 23.5$	*ns*
Months full time, mean (SD)	48.6 (21)	38.0 (6)	χ^2 (39, $n = 131$) $= 42.9$	*ns*
Months work placement, mean (SD)	5.5 (14.0)	4.3 (10.6)	χ^2 (15, $n = 131$) $= 10.6$	*ns*
MCCB Domain T-scores, mean (SD)				
Processing speed	36.6 (10.1)	35.1 (8.6)	t (126) $= 0.89$	*ns*
Attention	39.1 (10.6)	36.9 (9.2)	t (129) $= 1.26$	*ns*
Working memory	41.2 (9.7)	41.6 (9.5)	t (128) $= -0.24$	*ns*
Verbal learning	38.5 (7.9)	41.0 (10.7)	t (129) $= -1.50$	*ns*
Visual learning	36.3 (12.1)	38.0 (10.4)	t (129) $= -0.80$	*ns*
Problem solving	44.5 (10.0)	42.3 (9.2)	t (129) $= 1.21$	*ns*
Neurocognitive composite score	39.5 (6.4)	39.1 (6.6)	t (125) $= 0.35$	*ns*

[a] Degrees of freedom.
[b] Full-Scale IQ – 2 Subtests from the Wechsler Abbreviated Scale of Intelligence. SD = standard deviation.
[c] Defined daily dose (DDD).

$p = 0.03$, $\eta_p^2 = 0.06$). There was also a trend for attention ($F = 2.87$, $df = 2, 204$, $p = 0.06$, $\eta_p^2 = 0.05$).All improvements were in favor of CR.

Main effects for time were significant for processing speed ($F = 8.19$, $df = 2, 208$, $p < 0.001$, $\eta_p^2 = 0.13$), attention ($F = 5.02$, $df = 2, 204$, $p = 0.007$, $\eta_p^2 = 0.11$), visual learning ($F = 10.31$, $df = 2, 213$, $p < 0.001$, $\eta_p^2 = 0.18$), problem solving ($F = 5.29$, $df = 2, 216$, $p = 0.006$, $\eta_p^2 = 0.07$) and the composite score ($F = 13.41$, $df = 2, 178$, $p < 0.001$, $\eta_p^2 = 0.21$). There was a significant main effect for intervention for verbal learning ($F = 3.79$, $df = 1, 134$, $p = 0.05$, $\eta_p^2 = 0.05$).

All analyses were performed both with and without gender as a covariate. Gender did not influence any results.

3.3. Occupational outcome

Number of intervention hours differed significantly between groups, with a mean of 34.5 (*SD* 12.3) hours of CR and 29.5 (*SD* 11.7) hours of CBT (t (128) $= -2.36$, $p = 0.02$). Number of participants working either sheltered, in work placement or competitively, increased significantly between baseline and post treatment in both interventions. Between post treatment and follow-up, there was a slight decrease in both groups, but the total number of participants working remained significantly higher than at baseline. There were no between group differences in occupational status at any assessment point (Baseline; χ^2 (1, $n = 130$) $= 0.76$, $p = 0.4$. Post treatment; χ^2 (1, $n = 128$) $= 0.03$, $p = 0.9$. Follow-up (χ^2 (1, $n = 122$) $= 1.16$, $p = 0.30$) (Fig. 3). At post treatment, 10% were working competitively in the CBT group and 5% in the CR group whereas these percentages increased to respectively 22% and 16% at follow-up.

For number of hours worked, we found a continuous increase in both groups (Table 3).

3.4. Predictors of occupational outcome

Separate binary logistic regressions were carried out for the two interventions with occupational status at follow-up as criterion. Models contained demographics (gender, age, education and DOI), number of intervention hours and the MCCB-change scores between baseline and post treatment as covariates. The final model was significant for CR: (χ^2 (11, $n = 48$) $= 22.12$, $p = 0.02$), but not for CBT (χ^2 (11, $n = 47$) $= 6.57$, $p = 0.83$. Number of intervention hours emerged as a significant predictor ($p = 0.008$). Entering the composite change score instead of separate domains did not produce significant models for either group, although there was a trend for CR ($p = 0.07$). Exploratory analyses with competitive work as criterion did not yield significant models for either of the interventions; CBT ($p = 0.23$) and CR ($p = 0.07$), again with a trend for CR.

Separate multiple hierarchical regression analyses with hours worked as criterion was not significant for CBT ($F_{11, 20} = 1.79$, $p = 0.13$), but for CR ($F_{11, 18} = 2.78$, $p = 0.03$) explaining 62.9% variance. Significant predictors were education ($\beta = 0.54$, $t = 2.29$, $p = 0.03$) and the working memory change score ($\beta = 0.41$, $t = 2.53$, $p = 0.02$). Entering the composite change score as predictor instead of separate domains did not produce a significant model for CBT ($F_{6, 21} = 2.05$, $p = 0.10$). The final model was however significant for CR ($F_{6, 20} = 3.31$, $p = 0.02$), explaining 49.8% of the total variance. Significant predictors were age ($\beta = -0.47$, $t = -2.18$, $p = 0.04$) and the change in the composite score ($\beta = 0.50$, $t = 3.03$, $p = 0.007$).

4. Discussion

Participants in both groups demonstrated improvements in several neurocognitive domains. The greatest enhancements were found in

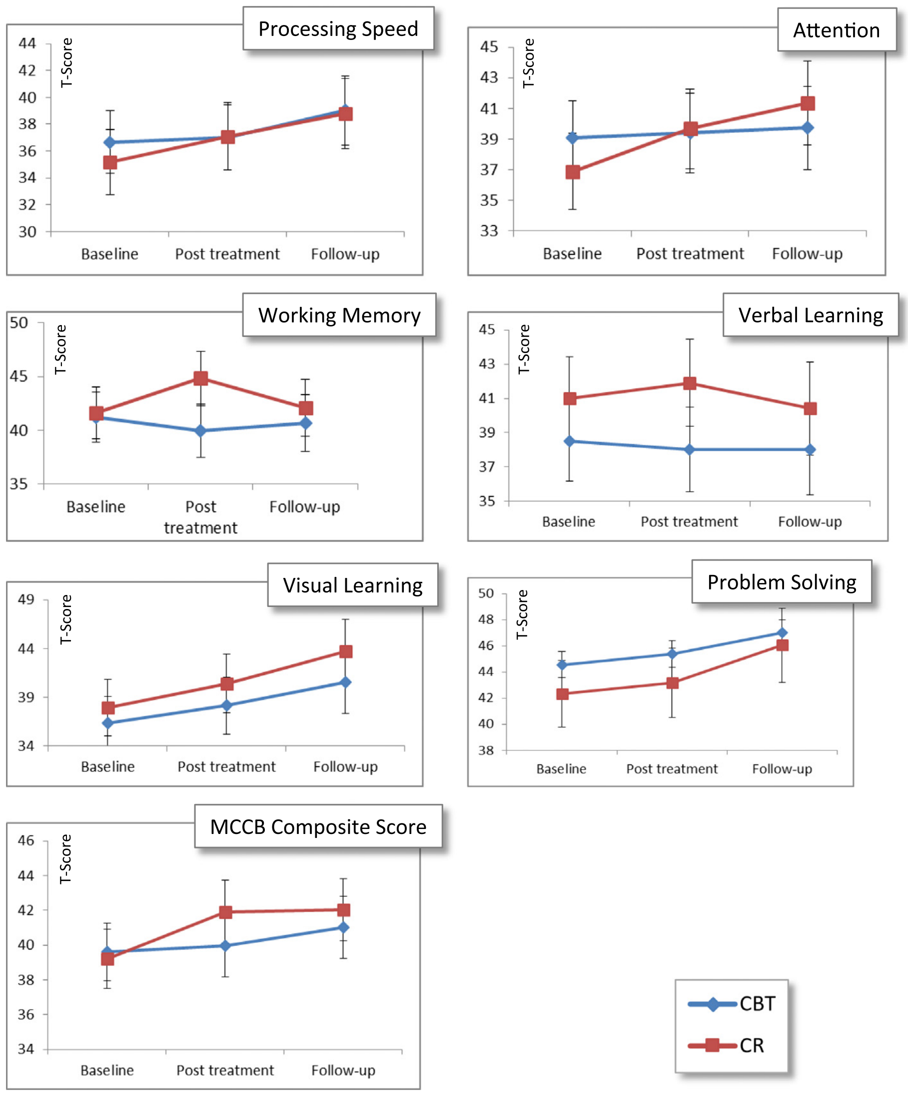

Fig. 2. Estimated marginal means and 95% confidence intervals for (left to right) processing speed, attention, working memory, verbal learning, visual learning, problem solving and neurocognitive composite score. There were significant between-group differences at post treatment on working memory and verbal learning.

the CR group, adding to extensive findings from similar studies (Bowie et al., 2012; Eack et al., 2009; McGurk et al., 2015). There was a main effect for CR on verbal learning, which has previously been strongly linked to functional outcome (Lepage et al., 2014) and shown to improve after CR (McGurk et al., 2009; Ostergaard Christensen et al., 2014; Sanchez et al., 2014). Given the indication that there may be a long-term decline of verbal learning (Bozikas and Andreou, 2011), the effect of CR on this domain is promising as it may reduce the influence of verbal learning impairment as a rate-limiting factor in VR.

We found significant improvements in working memory in the CR group at post treatment. A previous study documented similar effects (Ostergaard Christensen et al., 2014), albeit more pronounced between post treatment and follow-up. The larger effects at post treatment in our study may be linked to the fact that JUMP participants were provided with a real-world setting to practice their enhanced neurocognitive skills which was not the case in the NEUROCOM-trial. The CR program in the current study contained several verbal learning and working memory tasks, possibly contributing to a significant proportion of these effects. The findings may also be explained by additional strategy learning and bridging to work settings provided in the CR program. Applying compensatory strategies in addition to computer practice may reduce interference caused by neurocognitive impairments and lead to more sufficient allocation of neurocognitive resources. McGurk (McGurk et al., 2015) and colleagues combined CR strategy coaching and individualized compensatory strategies and found improvements in neurocognitive and occupational functioning in persons who did not respond to evidence-based SE. Further, employment specialists guided participants through all CR sessions, verbalizing goals and strategies, aiding in transfer of learning to vocational settings which consequently may have helped optimize occupational functioning. Neurocognitive performance continued to improve over time, although

Table 2
Effect sizes for both intervention groups from baseline to post treatment and baseline to follow-up assessments.

	Cohen's d baseline – post treatment		Cohen's d baseline – follow-up	
Domain	CBT	CR	CBT	CR
Processing speed	0.11	0.27	0.49	0.70
Attention	0.04	0.36	0.12	0.73
Working memory	−0.12	0.44	0.01	0.20
Verbal learning	−0.09	0.09	-0.02	0.07
Visual learning	0.18	0.20	0.41	0.70
Problem solving	0.07	0.07	0.31	0.51
MCCB neurocognitive composite score	0.31	0.80	0.47	1.16

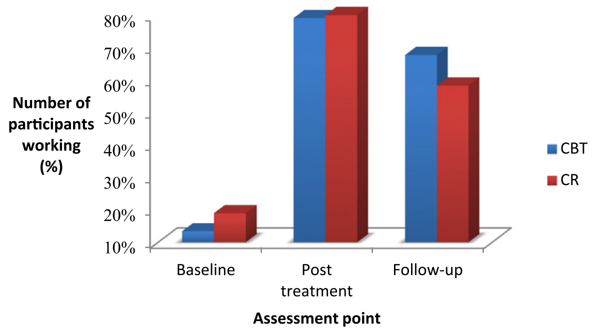

Fig. 3. Longitudinal course of participants working in the CBT and CR groups.

less markedly between post treatment and follow-up for most domains in the CR group, except for verbal learning and working memory, where we found a slight decrease. These domains were central in the CR program, and the decline at follow-up may thus be linked to the discontinuation of the computer-based training. Booster sessions may be sensible to ensure long-term effects. Also, the fact that the employment specialists were no longer there to remind participants of strategies in the follow-up phase may have had an impact.

Although not significant, there were some neurocognitive improvements in the CBT group as well. These improvements may on the one be rooted in the vocational rehabilitation, as VR programs have been found to positively influence neurocognition (Bio and Gattaz, 2011). On the other hand, they may reflect the structured approach that CBT is combined with elements such as verbalization techniques, repetitions and overlearning (Morrison, 2009).

With regard to occupational outcome, the major implication of these findings is that the combined effect of VR, organized collaboration between services and CBT/CR enabled a significant proportion of the JUMP participants to attain work and to increase the number of hours worked in the study. Occupational status at follow-up showed that even after termination of CBT/CR and the support provided by the JUMP trained employment specialists, a significant amount of participants were still employed, some competitively. Although we found an increase in participants working competitively throughout the project period, numbers were not as high as in SE/IPS studies. This should be interpreted in light of the strong tradition within the Nordic welfare model to offer sheltered work or work placement for lengthy periods (Hagen et al., 2011). The goal of paid employment is important and work placement may be a stepping stone on the path to competitive work. This tradition, in addition to relatively high social security benefits, provides a framework that is somewhat different than in other welfare systems, and may shed further light on competitive employment numbers in the JUMP study.

Positive neurocognitive change did not predict occupational status at follow-up in either group. A partially unexpected finding was that neither competitive nor sheltered employment was affected by neurocognitive change. Sheltered work may compensate for neurocognitive impairment to a greater extent than competitive work in terms of more flexible routines and less pressure; however, we established no differences between the two. Our findings indicate that for some persons, non-neurocognitive factors perhaps override these deficits or reduce their influence on work. Number of intervention hours was significantly related to occupational status in the CR group at follow-up with more hours increasing the probability of being employed, indicating that highly structured CR combined with compensatory strategies and support provided over time, may enable participants to acquire, practice and master essential occupational skills.

Table 3
Number of hours worked per week at baseline, post treatment and follow-up for the CBT and the CR groups.

		Mean number of hours worked	SD
Baseline	CBT	1.9	5.2
	CR	3.1	7.3
Post treatment	CBT	11.6	10.6
	CR	10.6	8.7
Follow-up	CBT	14.0	14.0
	CR	11.3	12.3

Education, change in working memory and the neurocognitive composite score predicted number of hours worked in CR. Education has previously been established as a predictor of occupational outcome (Cougnard et al., 2009; Kiejna et al., 2015; Swanson et al., 1998; Vargas et al., 2014) and may be indicative of work capacity, i.e. reflected in number of hours worked. Working memory was also found to predict return to work in a similar study (Nuechterlein et al., 2011) suggesting it is a potent predictor of occupational outcome and may be closely linked to occupational improvement (Brekke et al., 2009). The positive change in the neurocognitive composite score between baseline and post treatment predicted number of hours worked in the CR group, confirming its reliability in detecting change (Gray et al., 2014) and strengthening the support for the effect of cognitive remediation on occupational outcomes for persons with schizophrenia.

Some limitations to this study should be noted. The fact that we could not establish differences between CR and CBT regarding occupational outcomes suggests that both interventions are effective adjunctive elements in JUMP, however neither of them superior to the other with reference to number of participants working or the number of hours worked. Combined programs of CR and VR are frequently compared with groups receiving no additional treatment to VR (Au et al., 2015; Eack et al., 2009; Ostergaard Christensen et al., 2014), whereas in the present study two active interventions were provided. This, and the lack of a VR only control group, makes it difficult to determine the added value of CBT and CR to VR alone for neurocognitive and occupational outcomes.

In summary, these findings confirmed the importance of neurocognition in occupational functioning although the predictive value was moderate. There were improvements in several neurocognitive domains and an increase in number of participants working and hours worked. It is however important to underline that determinants of occupational functioning are multifaceted and driven by a number of both internal and external factors beyond those presented here.

Several questions need to be addressed in future research. Green et al. (2015) emphasize the importance of expanding beyond neurocognitive measures in predicting functional outcome and suggest learning potential as a possible mediator between neurocognition and real-world functioning. It is also important to further examine additive effects of strategy learning to CR, that is whether it may enhance gains on neurocognitive performance and to further unravel the complex underlying mechanisms of occupational functioning.

Conflict of interest

All authors declare that they have no conflicts of interest in regard to the research work presented in this manuscript.

Contributors

JUL: Study design, data collection, analysis, drafting and revising the manuscript. EF: Conception of the JUMP-study and revising the manuscript. VØH: Data collection and revising the manuscript. HB: Data collection and revising the manuscript. SE: Data collection and revising the manuscript. SRM: Contribution to and revising of the manuscript. TU: Conception of the JUMP-study, study design and revising the manuscript. All authors contributed and approved the final manuscript.

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