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Cognitive training for Hong Kong Chinese with schizophrenia in vocational rehabilitation

Key Messages

1. A randomised controlled trial was conducted to determine the effectiveness of a computerised, errorless, learning-based, training programme to enhance schizophrenic patients' cognitive functions and vocational outcomes.
2. A total of 80 Chinese with schizophrenia were randomly assigned to a 4-week, computer-assisted, errorless-learning (CAEL) group, a therapist-administered (TA) group, or a control group.
3. Participants were assessed pre-test, post-test, and at the 3-month follow-up. Cognitive, emotional, and vocational outcomes were measured using standardised validated instruments.
4. Participants in the CAEL and TA groups performed better than controls with respect to certain aspects of neurocognition. The CAEL group also had better self-efficacy (social skills and personal appearance) in work training and positive affect than the control group. The effectiveness of the intervention in the TA and CAEL groups was not similar. Vocational outcome after training was best predicted by both cognitive and emotional factors.
5. Combined use of an errorless learning and a computerised approach may be effective in enhancing the cognitive functioning and thus vocational outcome of Chinese patients with schizophrenia.

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Introduction

Work is important to everyone's life. It has beneficial effects to self-esteem, symptoms, economic standing, and satisfaction with finances, sense of recovery, and quality of living.[1] In the realm of mental health, work is important both in maintaining mental health and in promoting the recovery of those who have experienced mental health problems.[2] Nonetheless, people with mental disorders such as schizophrenia have impairment in work function, despite the desire to work.[1] Employment rates of people with severe mental illness range from 10 to 30% only.[1,3]

Basic cognitive function (attention, language comprehension) and higher cortical functions (reasoning such as similarity and judgement) are important predictors for vocational outcomes.[4,5] In addition to social skill and vocational skill training, cognitive training enhances the vocational outcomes and thus recovery and mental health of people with schizophrenia. Computer-assisted, cognitive rehabilitation programmes have been successfully applied to patients with schizophrenia and have provided equivalent or better training effect than traditional drilling methods, which use a trial-and-error approach and usually neglect the cognitive aspect of these patients. Committing errors during the learning process may be problematic for some persons with severe mental illness, as many of them have difficulties attending to a task, filtering out relevant information, or staying with a difficult task, and thus they endure multiple failures. Errorless learning is thus used to encourage active participation and to enhance the results by preventing errors. It is a better learning method than those depending on trial and error.[6]

This study aimed to compare a computer-assisted, errorless-learning (CAEL) training programme with a conventional therapist-administered (TA) errorless-learning programme and a control group for enhancing mental health and vocational outcomes of Hong Kong Chinese with schizophrenia. It was hypothesised that cognitive remediation using the errorless-learning approach delivered through a computerised mode or a therapist-administered mode could be efficacious interventions, and that the effect achieved by a computer-assisted and a therapist-administrated training programme would differ, despite using the same errorless-learning approach and the same content.

Methods

This randomised, controlled, double-blinded trial was conducted from October 2007 to December 2009. All participants were informed about the study and signed a consent form before commencement. Of 90 subjects with schizophrenia aged 18 to 55 years who were mentally stable and calm and had a basic attention span of at least 3 minutes, 80 completed the study and 10 dropped out (owing to early discharge, incomplete training or data set). The patients were randomly assigned into the CAEL (n=27), TA (n=23), or control (n=30) group (Table 1) and were assessed by independent raters pre-test, post-test, and at the 3-month follow-up. The patients and assessors did not know the expected results of the training programmes.

Patients were excluded if they had (1) impaired physical functions inhibiting the operation of a keyboard or mouse, (2) visual impairment such as blindness, partial blindness and other visual problems, (3) other neurological problems such as epilepsy, (4) pre- and post-morbid mental retardation of severe or moderate grades, (5) previous training of similar computerised programmes, or (6) a deviation quotient of <85 in the Test of Nonverbal Intelligence version III (TONI-3),[7] which is a language-free intelligence test that measures abstract/figural problem-solving ability.

The 12-session CAEL and TA programmes were developed based on the work scenario of a convenience store worker involving four major tasks: stock keeping, cleansing, food servicing, and cashiering. Five principles of errorless learning were applied: (1) the to-be-learned task was broken down into components, (2) training began on simple tasks and proceeded gradually to more difficult ones, (3) high levels of success were maintained at each stage with use of aids and abundant positive reinforcement, (4) each component was over-learned through repetitive, successful practice until performed nearly automatically, and (5) the learned components were recombined, adding one component at a time, until the task was trained entirely. The TA programme was produced by print-screening the scenes of CAEL to form an administration handbook for each session. Thus the two programmes were of similar content and structure, but different in the mode of delivery.

Outcome measures included: (1) the Wisconsin Card Sorting Test (WCST) computer version 4,[8] which assesses executive function—the abstract reasoning ability and the ability to shift cognitive strategies in response to changing environmental contingencies. It was used to obtain information of the subject's learning ability by the cognitive level of flexibility to learn in response to a changing environment. (2) The Neurobehavioral Cognitive Status Examination (NCSE) Chinese version,[9] which is a standardised examination of global cognitive function. It assesses multiple domains of cognitive functioning, namely: orientation, attention, language, construction, memory, calculation and reasoning. It was used to detect changes in the global cognitive functioning of the subjects after training. (3) The Vocational Cognitive Rating Scale (VCRS),[10] which measures cognitive impairment that clients with chronic mental illnesses may experience in the workplace. It includes 16 items that are phrased with behaviourally based anchors. It was used to compare vocational cognitive functioning of subjects. (4) The self-efficacy scale, which is a 10-item questionnaire to rate subject's self-efficacy on the ability to perform tasks of a convenient shopkeeper. It was used to detect the difference of subjects' self-efficacy in being a shopkeeper after training. (5) The Chinese Work Personality Profile (CWPP),[11] which is a behavioural rating instrument for use in employment settings that provides a broad assessment of the vocational circumstance. Five domains of work behaviours (task orientation, social skills, self-control, attitude towards supervision, and personal appearance) were assessed in the work settings. It was used to reflect effectiveness of the training on the actual working performance and to detect any changes in the working personality of the client. (6) The Positive and Negative Affect Scale (PANAS) Chinese version,[12] which independently measures positive and negative moods. It consists of 20 adjectives (10 each for positive and negative mood states). It was used to detect positive and negative emotional responses of the subject. (7) The vocational outcomes, which is defined by five categories: open employment, vocational training, supported employment, sheltered workshop, and unemployment.

Results

The CAEL, TA, and control groups were not significantly different with respect to subject demographics (gender, medication, marital status, and TONI-3 score), except

Table 1. Demographics of schizophrenic patients in the computer-assisted errorless-learning (CAEL), therapist-administered (TA), and control groups*

Variable	CAEL group (n=27)	TA group (n=23)	Control group (n=30)
Age (years)	34.9±8.5 (19-49)	41.6±7.7 (24-54)	35.1±10.2 (18-50)
Deviation quotient (Test of Nonverbal Intelligence version III)	88.7±14.3 (75-135)	87.7±17.7 (63-135)	90.6±12.5 (64-116)
Gender			
Male	15 (56)	14 (61)	21 (70)
Female	12 (44)	9 (39)	9 (30)
Education			
Primary	3 (11)	0 (0)	6 (20)
Secondary	23 (85)	23 (100)	20 (67)
Post-secondary	1 (4)	0 (0)	4 (13)
Marital status			
Single	23 (85)	18 (78)	24 (80)
Married	3 (11)	3 (13)	6 (20)
Widowed	1 (4)	0 (0)	0 (0)
Divorced	0 (0)	2 (9)	0 (0)
Medication			
Typical	9 (33)	9 (39)	11 (37)
Atypical	18 (67)	11 (48)	18 (60)
Both	0 (0)	3 (13)	1 (3)

* Data are presented as mean±SD (range) or No. (%) of patients

Table 2. Instrument scores of schizophrenic patients pre-test, post-test, and at the 3-month follow-up*

Instrument	Computer-assisted errorless-learning group			Therapist-administered group			Control group		
	Pre-test (n=27)	Post-test (n=27)	Follow-up (n=18)	Pre-test (n=23)	Post-test (n=23)	Follow-up (n=15)	Pre-test (n=30)	Post-test (n=30)	Follow-up (n=24)
Vocational Cognitive Rating Scale	53.7±9.3	54.7±8.6	-	52.7±9.0	52.1±9.2	-	53.5±13.7	54.0±13.6	-
Wisconsin Card Sorting Test									
Total correct	63.5±19.3	69.6±18.6	64.2±16.4	67.3±20.4	61.7±18.9	63.6±11.6	70.9±18.2	70.0±15.5	70.5±19.9
Total error	58.7±26.1	48.6±27.4	49.7±31.0	54.7±26.2	54.5±30.8	40.0±30.9	52.5±22.6	44.5±25.9	46.3±24.7
% of error	46.8±19.1	39.1±20.0	40.3±22.3	43.9±19.3	44.1±22.3	35.1±21.1	41.9±16.6	36.7±18.3	38.7±18.6
Preservative error	29.1±19.2	25.5±20.0	21.6±20.1	29.3±21.2	27.4±20.4	18.4±13.4	29.7±19.0	24.6±20.0	27.0±20.7
% of preservative error	23.2±14.6	20.5±15.1	17.6±15.1	23.4±16.1	22.1±15.3	16.1±9.0	23.6±14.4	20.2±15.0	22.3±15.7
Conceptual level response	46.4±26.4	54.3±26.7	50.0±24.5	50.6±27.9	45.2±27.8	50.1±22.3	54.4±23.7	55.7±21.6	56.3±25.1
Categories completed	2.7±2.1	3.3±2.5	3.2±2.6	3.1±2.4	2.9±2.7	3.7±2.9	3.5±2.2	3.8±2.4	4.0±2.4
Neurobehavioral Cognitive Status Examination									
Orientation	11.3±1.0	11.6±0.8	11.7±0.5	10.9±1.6	11.3±1.3	10.0±2.2	11.2±1.2	11.4±1.2	11.4±1.2
Attention	8.0±0.0	8.0±0.2	8.0±0.0	8.0±0.0	8.0±0.0	8.0±0.0	7.7±1.5	7.7±1.2	7.8±0.7
Language	20.7±4.3	22.4±3.3	23.0±3.1	21.0±4.2	22.0±3.9	20.9±5.1	21.5±3.6	21.9±2.9	21.6±3.4
Construction	4.9±1.7	5.3±1.0	5.3±1.0	4.3±1.7	4.7±1.7	4.6±2.1	5.3±1.1	5.1±1.5	5.0±1.7
Memory	9.6±3.3	9.6±3.4	9.8±3.4	8.6±3.4	9.0±3.7	8.8±3.9	9.1±3.2	9.2±2.8	9.2±3.5
Calculation	3.7±0.7	3.9±0.3	3.9±0.3	3.4±1.2	3.9±0.5	4.0±0.0	3.5±1.1	3.6±1.0	3.6±0.9
Reasoning	12.3±2.4	13.2±1.6	12.2±2.6	11.9±2.6	12.7±2.5	12.5±3.0	10.5±3.0	10.8±2.6	11.0±3.1
Chinese Work Personality Profile									
Task orientation	73.4±7.4	75.1±8.4	-	73.0±8.0	71.8±8.5	-	68.9±15.3	69.1±15.2	-
Social skills	41.6±5.0	42.7±5.7	-	41.1±6.4	41.0±7.2	-	37.7±6.8	37.9±6.5	-
Self control	20.9±2.2	21.3±2.2	-	20.7±1.7	20.8±2.2	-	20.0±3.5	20.0±3.6	-
Attitude towards supervision	26.8±3.3	27.7±3.6	-	27.1±4.2	26.9±4.1	-	25.4±4.8	25.3±4.4	-
Personal appearance	6.1±1.2	6.0±1.0	-	6.3±1.1	6.0±1.1	-	6.5±0.9	6.5±0.9	-
Self-efficacy scale	72.0±18.3	79.7±6.3	-	69.5±20.8	72.6±18.6	-	68.0±19.1	65.2±20.9	-
Positive and Negative Affect Scale									
Positive	30.2±6.5	31.0±6.3	30.5±6.5	29.3±7.5	27.6±6.1	26.1±7.7	29.3±7.5	29.1±7.5	29.9±6.7
Negative	24.0±9.4	20.9±8.2	25.0±7.3	22.4±8.6	22.4±10.3	20.1±6.2	20.6±7.4	21.9±8.4	22.6±7.8
Vocational outcome at follow-up									
Vocational training	-	-	15 (33)	-	-	10 (67)	-	-	-
Sheltered workshop	-	-	1 (6)	-	-	3 (20)	-	-	-
Supported employment	-	-	2 (11)	-	-	2 (13)	-	-	-

* Data are presented as mean±SD or No. (%) of patients

for age (F=4.40, P=0.015) and education level (Chi-square=10.54, P=0.032) [Table 1]. The three groups were also not significantly different in terms of baseline outcome measures (VCRS, WCST, NCSE, NCSE, PANAS, and the self-efficacy scale), indicating comparable pre-test status (Table 2). Interacting effects were not significant in the VCRS and WCST, even when repeated analysis of variance (ANOVA) was applied, age was adjusted, and education levels were stratified.

For NCSE, after adjusting for age, the group effect was significant in the reasoning domain only (F=6.460, P=0.003, multivariate ANOVA [MANOVA]), and the CAEL and TA groups performed significantly better than the control group. For subjects with primary education, the group effect was significant in the language domain (F=7.480, P=0.034, MANOVA), and the CAEL group performed significantly better than the control group (t=2.443, P=0.045). For those with secondary education, the group effect was significant in the reasoning domain (F=6.561, P=0.003, MANOVA), and the CAEL and TA groups performed significantly better than the control group in the ANOVA and post-hoc (Bonferroni) test. For those with post-secondary education, no significant group effect was noted on all domains.

For CWPP, after adjusting for age, the group effect was significant in the social skill domain only (F=3.98, P=0.023, MANOVA), and the CAEL group (but not the TA group) performed significantly better than the control groups. For the other four domains, there was no significant group effect. For those with secondary education, the group effect was significant in the social skill domain (F=3.46, P=0.037, MANOVA). For those with post-secondary education, the group effect was marginally significant in the personal appearance domain (F=15.64, P=0.058, MANOVA).

For the self-efficacy scale, after adjusting for age, no significant group effect was noted (MANOVA). For those with primary education, the group effect was marginally significant (F=3.865, P=0.097, MANOVA). For those

with secondary education, the group effect was significant (F=3.909, P=0.025, MANOVA). The CAEL group had better self-efficacy than the control group (ANOVA and post-hoc test), whereas the CAEL and TA groups did not differ significantly (F=4.232, P=0.018). For those with post-secondary education, no significant group effect was noted (MANOVA).

For PANAS, group effect was significant for positive scores only (F=3.53, P=0.043) among patients with secondary education. The CAEL group had a better positive affect than the control group, and the CAEL and TA groups were not significantly different (ANOVA and post hoc test).

For vocational outcome, the CAEL, TA, and control groups were not significantly different at the 3-month follow-up (Chi-square=3.378, P=0.497). Most patients were still receiving vocational training (n=46 [15+10+21, respectively], 80.7%), whereas others were attending a sheltered workshop (n=6, 10.5%) or having support employment (n=5, 8.8%). There were significant differences in self-efficacy, WCST, NCSE, and PANAS scores among patients in each of the three vocational outcomes. Thus, discriminant analysis was carried out to determine whether post-training outcome measures at the 3-month follow-up could help to predict vocational outcome.

The canonical correlation between self-efficacy and vocational outcome was low (0.112), as were the classification function coefficients of self-efficacy versus each of the vocational outcomes (vocational training, sheltered workshop, and supported employment). The values were 0.146, 0.156, and 0.13, respectively. From the classification table, if only self-efficacy was used to predict the vocational outcome, the overall classification rate was only 36.8%. Similarly, for discriminant analysis, the canonical correlations between WCST and vocational outcome were not high (0.403 and 0.231, respectively). The classification function coefficients of WCST (categories completed) and percentage of errors with the three vocational outcomes (2.14, 2.11, and 2.06, respectively) were higher than that for the percentages of preservation errors and conceptual level responses. If WCST subtests including categories, percentage of errors, percentage of preservation errors, and conceptual level response were used to predict the vocational outcome, the overall classification rate was at the acceptable level of 54.4%.

The classification function coefficients of NCSE (attention) and NCSE (calculation) with each of the vocational outcomes were higher, compared to other NCSE components. From the classification table, if all NCSE components were used to predict the vocational outcome, the overall classification rate was high (75.4%).

The canonical correlation between PANAS (positive and negative) score and vocational outcome was low (0.187 and 0.025, respectively). The classification function coefficients of positive and negative PANAS scores with each of vocational outcomes were lower, because the coefficients were <1. If PANAS positive and negative scores were used to predict the vocational outcome, the overall classification rate of 56.1% was acceptable.

Discussion

The short-duration training (CAEL or TA) did not result in significant differences in VCRS and WCST. The VCRS may not be a sensitive tool in detecting changes when subjects were being observed in doing real work tasks. The training intensity may be too low for positive transfer of skills, and the content may not be relevant. The ecological validity of WCST (a laboratory-based test, assessing abstract reasoning, and execution of card activities on a computer screen) is questionable and may also limit its use in real-life, work-related task.

For global cognitive function as indicated by NCSE, only the component score of reasoning was better in the CAEL and TA groups than controls. For those having primary and secondary education, the CAEL group performed better than controls in both NCSE (language) and NCSE (reasoning). Therefore, limited but positive changes in cognitive functions were indicated, and the CAEL group was more effective.

For CWPP (social skills), the CAEL group performed better than controls. For patients with secondary and post-secondary education, the CAEL group performed better than controls in social skills and personal appearance, respectively. This suggested that computer training provided an efficacious training effect on work behaviour (social skills, personal appearance) for those with better education.

For self-efficacy, in patients with primary and secondary education, those in the CAEL group performed better in shop keeping than controls, whereas the CAEL and TA groups were not significantly different. This suggested that the computer training content was able to change subjects' self-evaluation of their own competence in performing the required task, as comparable to the documented therapist's face-to-face role in motivation and provision of positive feedback. This computerised training approach may be an alternative means of motivating patients in job training.

For PANAS, no significant change in positive and negative affect among the three groups was noted, except that the CAEL group had a more positive affect than controls after training. This suggested that computer training itself may influence the subjects' affect. Although CAEL and TA entailed similar content, the computer programme seemed to provide an additional benefit to the emotional adjustment of the subjects.

For vocational outcome, there was no significant

difference in the three groups at the 3-month follow-up. Vocational outcome was limited to three of the five pre-set categories (vocational training, supported employment, sheltered workshop). None of the patients had open employment. The training programmes may be too content-specific (restricted to manual work) to empower them for successful open employment. Other pertinent factors predicting successful work placement should also be considered.

In the discriminant analysis, both cognitive (WCST, NCSE) and emotion functions (self-efficacy, PANAS) were equally important in predicting vocational outcomes. Future training programme or discharge plans for persons with schizophrenia should provide well-balanced cognitive and self-efficacy training, which can be achieved by an increased awareness and emphasis on innovative cognitive training and by conventional training in social skills, assertive training, and group therapy.

Due to the limited time and the number of subjects, the sample size was not large enough, especially at the 3-month follow-up. Although the dosages of antipsychotic drugs were maintained at the same level before and during the study period, the medication effect might have made them feel tired and less motivated, which might not be the best time point to conduct the training. In the TAG, the investigators had to conduct face-to-face delivery of the feedback that was similar to the CAELG training programme, but there was no standardised training method for the therapists.

Suggestions for future studies are: (1) training could be increased to six sessions per week to a total of 20 sessions or more, so as to enhance the over-learning effect and help the participants become familiarised with the tasks. (2) A well-defined scoring system should be incorporated into the computer programme. (3) A placement of convenient shopkeeper's tasks should be included as an outcome measure at the end of each week for more precise evaluation of the participants' actual performance. (4) In the TA group, the investigators should formulate a general rule about feedback to the participants during the training.

Conclusions

Although the CAEL group did not show a significant effect with respect to most of the cognitive, emotional, and vocational outcomes, improvement in the component scores of NCSE (reasoning, language), self-efficacy, and PANAS (positive affect) demonstrated possible learning of cognitive skills in relation to vocational tasks. Learning may be enhanced by the errorless-learning method and may be feasibly delivered by a computerised training programme. Through examining the new vocational outcome predictors of cognition (reasoning and problem solving), the vocational rehabilitation treatment programme can be more specific and tailor-made for schizophrenic patients.

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References

1. Mueser KT, Salyers MP, Mueser PR. A prospective analysis of work in schizophrenia. Schizophr Bull 2001;27:281-96.
2. Boardman J, Grove B, Perkins R, Shepherd G. Work and employment for people with psychiatric disabilities. Br J Psychiatry 2003;182:467-8.
3. Marwaha S, Johnson S. Schizophrenia and employment: a review. Soc Psychiatry Psychiatr Epidemiol 2004;39:337-49.
4. McGurk SR, Mueser KT. Cognitive functioning, symptoms, and work in supported employment: a review and heuristic model. Schizophr Res 2004;70:147-73.
5. Pilling S, Bebbington P, Kuipers E, et al. Psychological treatments in schizophrenia: II. Meta-analyses of randomized controlled trials of social skills training and cognitive remediation. Psychol Med 2002;32:783-91.
6. Evans J, Wilson BA, Schuri U, et al. A comparison of 'errorless' and 'trial-and-error' learning methods for teaching individuals with acquired memory deficits. Neuropsychol Rehabil 2000;10:67-101.
7. Brown L, Sherbenou RJ, Johnsen S.K. TONI-3 test of nonverbal intelligence: a language-free measure of cognitive ability. 3rd ed. Austin, Texas: Pro-ed; 1997.
8. Heaton RK. Wisconsin Card Sorting Test Manual: Computer Version 4 (WCST: CV4), Research Edition. Lutz, Florida: Psychological Assessment Resources; 2003.
9. The Northern California Neurobehavioral Group. Cognitstat: The Neurobehavioral Cognitive Status Examination in older psychiatric population. Fairfax, California: The Northern California Neurobehavioral Group; 1995.
10. Greig TC, Nicholls SS, Bryson GJ, Bell MD. The vocational cognitive rating scale: a scale for the assessment of cognitive functioning at work for clients with severe mental illness. J Vocat Rehabil 2004;21:71-81.
11. Law CK, Siu AM, Lee JL, Lee SW. Prediction of work rehabilitation placements using the Chinese Work Personality Profile. Psychiatr Rehabil J 2006;30:120-8.
12. Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: the PANAS scales. J Pers Soc Psychol 1988;54:1063-70.