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ORIGINAL REPORT

COMPARISON OF ATTENTION PROCESS TRAINING AND ACTIVITY-BASED ATTENTION TRAINING AFTER ACQUIRED BRAIN INJURY: A RANDOMIZED CONTROLLED STUDY

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Objectives: To compare the effects of 2 interventions for attention deficits in people with acquired brain injury, Attention Process Training (APT) and Activity-based Attention Training (ABAT), on activity and participation.
Design: Randomized controlled study.
Patients: The study included 51 patients in outpatient rehabilitation 4–12 months after stroke or traumatic brain injury.
Methods: Intervention: 20 h of attention training. Measurements: Assessment of Work Performance (AWP), Work Ability Index (WAI), Canadian Occupational Performance Measure (COPM), and Rating Scale of Attentional Behavior (RSAB).
Results: Between-group comparisons showed significantly improved process skills after APT: Mental Energy ($p=0.000$, ES = 1.84), Knowledge ($p=0.003$, ES = 1.78), Temporal Organization ($p=0.000$, ES=1.43) and Adaptation ($p=0.001$, ES = 1.59). For within-group comparisons significant improvement was found between pre- and post-measures for both groups on COPM Performance (APT: $p=0.001$, ES=1.85; ABAT: $p=0.001$, ES = 1.84) and Satisfaction (APT: $p=0.000$, ES=1.92; ABAT: $p=0.000$, ES = 2.40) and RSAB Total Score (ABAT: $p=0.027$, ES = 0.81; APT: $p=0.007$, ES = 1.03).
Conclusion: We found significant differences favouring APT before ABAT for process skills (AWP). There were no discernible differences in global measures of activity between the 2 approaches: both groups improved significantly, as indicated by ES. The results of this study highlight the complexities of influencing behaviour on the level of body functions while measuring effects on activity.

Key words: cognitive rehabilitation; performance-based assessments; stroke; traumatic brain injury; process skills; work ability.

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LAY ABSTRACT

The focus of this study is on training of attention deficits after acquired brain injury. The study compared 2 training methods; one directly training attention (Attention Process Training; APT) and another training attention in daily activities (Activity-based Attention Training; ABAT). The APT group improved somewhat more in work performance skills regarding organization of tasks, maintaining focus and adjusting to changes, compared with the ABAT group. The APT group rated an improvement from poor to moderate work ability, while the ABAT group maintained poor work ability. Self-assessed work ability was not estimated "excellent" for any participant at any assessment point. Both groups demonstrated medium to large improvements in performance ratings for daily activities and for satisfaction in performance. Their attention improved, as observed by physiotherapists/occupational therapists during training.

Acquired brain injury (ABI) may result in wide-ranging impairment and reduced participation in everyday situations. The most frequent causes are stroke (25,700 people/year in Sweden) (1) and traumatic brain injury (TBI) (262/100,000 people/year in Europe) (2) Attention deficits are among the most frequent cognitive symptoms and may lead to difficulties in activities related to daily life, work, and social activities. Maintaining focus for short periods, a basic process, mostly recovers. However, difficulties with higher-order attentional processes, such as working memory, switching between tasks, and dividing attention, may persist (3, 4). The presence of these deficits has a significant negative impact on vocational outcomes, particularly if the person's work requires planning, problem-solving, concentration, organization, and good memory skills (5).

Successful return to work after ABI is influenced by complex and interactive factors, such as requirements in a work situation, individual psychosocial and emotional prerequisites, and work-related support systems (5). At the same time the assessment of work performance is challenging during the rehabilitation period, since the environment is not realistic. The demands of real-life situations with distractions, and unpredictable task demands may impair performance. Performance-based assessments are presumed to bridge the gap and better reflect these cognitive aspects in real-life situations as measures of participation in daily life and society (6).

Attention deficits may improve through systematic, targeted cognitive training. Although a recent Cochrane review found that the effectiveness of attention training on attentional skills in daily life following stroke remains unconfirmed (7) a meta-analysis (8) found an effect size

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of 35-38% for attention training in adults. One of these methods, the Attention Process Training (APT) (9) was found to be successful during both the chronic phase after ABI (9) and early, (<4 months) after ABI (10). APT has been recommended as standard practice during post-acute rehabilitation following TBI (11).

The significance of cognitive functioning for successful work return has been evident in brain injury rehabilitation, and the importance of cognitive remediation has been pointed out by Mitrushina & Tomaszewski (12). By tradition, cognitive rehabilitation has been evaluated on the level of measurements of body functions, but the lack of ecological validity and evaluation of transfer effects are questioned (13).

New advances in occupational therapy, the Cognitive Orientation to Occupational Performance (CO-OP) with the integration of performance skills training and metacognitive strategy training attempt to bridge this gap. Several studies have shown improved performance on trained tasks, and greater transfer of training to untrained tasks, although the specific effective components of the CO-OP procedure have not been analysed (11).

Positive effects of attention training on daily life following APT training have been demonstrated when patients use self-reported assessments or interviews. Only a few studies have used performance-based instruments (14, 15), as in the current study.

This randomized controlled trial (RCT) study aims to compare the effect of 2 cognitive rehabilitation approaches using measurements on activity level; one approach, the APT, focusing on structured, intensive, process-oriented attention training, and the other approach, the ABAT, trying to improve attention through activity-based training. It was hypothesized that the APT would be more effective, due to its systematic, hierarchical, and theoretical basis.

METHODS

This study is part of a larger registered clinical trial (clinical trials.gov: NCT02091453), a prospective 2-armed RCT study of patients during the first year after ABI (16). Data were collected in 2 cohorts, during 2 time-periods post-ABI, within 4 months (cohort 1) and 4–12 months (cohort 2) post-ABI (10, 16, 17). The Regional Ethics Review Board approved the protocol at Karolinska Institutet in Stockholm, Sweden (clinical trials.gov: NCT02091453). Participants received oral and written information, and they all provided written consent.

Participants were patients with stroke or TBI (n=51), referred to outpatient rehabilitation approximately 6 months (range 4–11.5 months) after ABI.

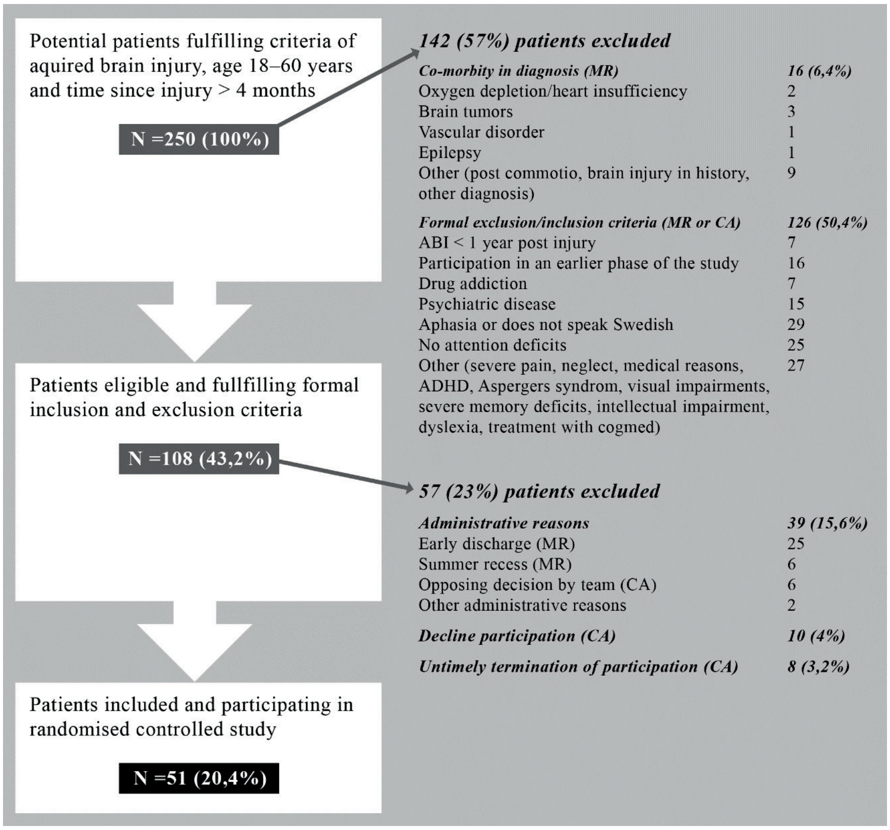

Fig. 1. Flow chart of inclusion and exclusion based on medical records (MR) and clinical assessment (CA). Values are expressed as number and percentage of the total number of participants. MR: medical records; CA: clinical assessment; ABI: acquired brain injury; ADHD: attention deficit hyperactivity disorder

Inclusion criteria were: patients 4–12 months after injury, age range 18–60 years, and with mild to moderate stroke or TBI according to their symptom picture and severity (Fig. 1). Further inclusions criteria were: attention deficit, defined as 70% or less correct on at least 2 of the 5 subtests in the diagnostic test for the APT (9), a standard score ≥7 for Matrix reasoning (Wechslers Adult Intelligence Scale, WAIS-III) (18) (abstract thinking and reasoning) and sufficient knowledge of Swedish.

Exclusion criteria were: aphasia, severe pain, ongoing psychiatric illness or substance abuse; severe bilateral motor or visual impairment that made participation impossible; neglect with a cut-off score (≥2), measured with Albert's test/Line crossing (18).

A flow chart of the process is shown in Fig. 1. Demographic data are presented in Table I.

Procedure

Consecutive patients were included in the study, based on the inclusion and exclusion criteria. They underwent a baseline assessment and were randomized to 1 of the 2 intervention programmes. Block randomization by an external researcher was used. The intervention started within 2 weeks after the baseline assessment. Post-intervention assessment was administered within 2 weeks, and a follow-up assessment was administered 3 months later. The post- and follow-up assessments were not blinded, as the evaluations were performed by therapists in the participants' team.

Table I. Main demographic and clinical characteristics of the participants for the 2 treatment groups: Attention Process Training (APT) and Activity-based Attention Training (ABAT)

	APT	ABAT
Participants (N)		
N at pre test	25	26
N at post test	25	26
N at follow-up test	24	21
Sex (F/M)	17/8	13/13
Age, years, mean (SD)	46.6 (9.6)	49.9 (8.9)
Education, years		
< 9 years	1	3
9–12 years	7	7
≥ 13 years	17	16
Employed before participation	25	26
Diagnosis TBI/stroke	5/20	7/19
Time since injury, days, mean (SD)	184.2 (66.7)	174.6 (56.1)
Injury side		
Left hemisphere	7	11
Right hemisphere	10	6
Bilateral	6	8
Other[1]	2	1
Injury distribution		
Fokal	16	14
Multifokal (≥ 2)	7	11
DAI	2	1
Injury localization		
Anterior	7	4
Posterior	4	5
Subcortical	11	10
Global	3	7
APT test, mean (SD)		
Focused attention	93.4 (10.5)	93.2 (11.1)
Sustained attention	41.2 (22.5)	28.7 (16.9)
Selective attention	39.4 (23.8)	31.7 (20.0)
Divided attention	91.4 (10.7)	84.0 (16.0)
Alternating attention	33.8 (22.3)	22.8 (22.5)

[1]injury in mesencephalon or not defined diffuse axonal injury (DAI). SD: standard deviation, F: female; M: male; TBI: traumatic brain injury; DAI: diffuse axonal injury

Outcome measures

The selected outcome measures focused on occupational performance in different areas of daily life:

- work performance in a specific cognitively demanding task (Assessment of Work Performance; AWP), analysing performance skills, i.e. observable small units of behaviour used to organize and complete a specific task;
- work ability in several dimensions (Work Ability Index; WAI);
- self-perceived occupational performance (Canadian Occupational Performance Measure; COPM);
- impact of attentional behaviour in daily life (Rating Scale of Attentional Behavior; RSAB);
- self-perceived occupational performance and satisfaction with performance.

Assessment of Work Performance

The Assessment of Work Performance (AWP) (19) is a performance-based observational measure assessing how efficiently and appropriately an individual performs a work task. A total of 14 skills in 3 domains, process, motor and communication skills, are evaluated (See Appendix 1). The successful performance of a task is based on the constellation of skills needed. Performance skills are produced by the effective use of body functions for a task with interaction with the environment.

AWP Process skills are further divided into Mental Energy (ability to perform and complete the work with maintained attention and without becoming fatigued), Knowledge (ability to acquire, learn and use knowledge and tools and perform a work task according to aim and goal), Temporal Organization (ability to organize and perform task moments in a logical sequence), Organization of Space and Objects (ability to organize workspace and tools) and Adaptation (ability to adjust behaviour and adapt the environment as a reaction to perceptual or environmental performance cues). These process skills require attentional functioning to a different extent. Furthermore, possible effects of attention training can be observed only in those process skills that utilize attention to some extent. The AWP has shown good psychometric properties concerning content validity and utility (20) as well as construct validity (21).

For comparison between interventions, a Structured Work Task application for the AWP was developed and evaluated, the Attention-demanding Registration Task (AdRT) (22) with high demands on process skills. The AdRT showed high sensitivity and specificity in differentiating between patients with attention deficits and a healthy working group; 9 out of 10 participants were placed in the correct group (22). The AWP was used for pre-, post, and follow-up evaluations.

Work Ability Index

The WAI (23) is a self-report measure, evaluating work ability in 7 dimensions: (a) current work ability compared with life-time best (presented as a visual analogue scale); (b_1/b_2) work ability concerning physical and mental demands in current work; (c) the total number of medical diagnoses; (d) estimated work impairment due to diseases; (e) sickness absence during the last year; (f) expected work ability in the forthcoming 2 years, and (g) enjoyment of regular daily activities (mental resources). The scores were summed to a total score for the WAI with (range 7–49) and without (range 6–42) list of diseases. The first author controlled the number of diagnoses based on medical records, to ensure reliability.

The total WAI score was grouped into 4 groups: groups 1: "poor", scores 7–27 (need to restore work ability); group 2: "moderate”, scores 28–36 (need to improve work ability); group 3: “good”, scores 37–43 (need to support work ability); and group 4: “excellent”, scores 44–49 (need to maintain work ability).

Psychometric properties of the WAI showed the internal consistency of the 7 items was altogether 0.82 (24), further discriminative validity for people with high and low risk of long-term sick leave (25) and acceptable predictive validity (26). The WAI was used for pre-, post, and follow-up evaluations.

Canadian Occupational Performance Measure

The COPM (27) was used to assess self-perceived occupational performance and satisfaction with performance. The therapist begins with a semi-structured interview to identify problems in areas of self-care, productivity, and leisure. After the patients had identified the problems, they rated the importance of each activity on a scale of 1–10. From this list, the person chose 5 problems on which to focus. For each problem, 2 scores were obtained, 1 for performance and 1 for satisfaction with the performance of the selected activity (1 = not able to do, to 10 = able to do it very well) (1 = not satisfied to 10 = extremely satisfied). Higher self-ratings reflect better performance and satisfaction with performance. The COPM was not administered at follow-up for clinical and organizational reasons.

Rating Scale of Attentional Behavior

The Rating Scale of Attentional Behavior (RSAB) (28–30) is an observational measure to assess the impact of attentional impairment on everyday behaviour. The therapist rates the observed difficulties. Ponsford & Kinsella (28) developed the 14-item scale based on the concepts of alertness, selective and sustained attention. Scoring is on a 5-level Likert-type scale; higher scores indicating more severe impairment (0 = not at all, 4 = always). The maximum score is 56. Since RSAB requires daily observation of performance for 1 week, this instrument could not be used at the follow-up assessment.

Interventions

The participants took part in intensive interdisciplinary brain injury rehabilitation programme accredited by the Commission on Accreditation of Rehabilitation Facilities (CARF)-accredited interdisciplinary brain injury rehabilitation programme (5 h/day, 3–4 days weekly, for a period of 6–10 weeks including the assessment period). Attention training with APT or ABAT was administered for 20 h, 3–5 h per week, for 4–6 weeks. APT was administered by 4 different trainers; 3 occupational therapists (OTs) and 1 neuropsychologist. The patient’s ordinary OT administered ABAT, supervised by 1 of the investigators. Regular discussions between OTs and investigators ensured the comparable quality of treatment and focus on attention.

Attention Process Training

APT (9) is a process-oriented and theoretically-based individualized attention training programme, translated into Swedish, which also addresses generalization of strategies. It is hierarchical, with increased difficulty and complexity in visual and auditory exercises. To assure consistent treatment dosage this was registered separately. Training was provided individually and in a private room.

Activity-based Attention Training

The ABAT was based on core occupational therapy, aimed at optimizing occupational performance in attention-demanding activities and teaching compensatory strategies (31). The training involved attention-demanding activities, such as household and computer-based activities, simulated work tasks, and paper-and-pencil tasks. Type of training and the time for a specific training were registered. The training was provided individually or in a group format leading to more distracions.

Statistical analysis

BM SPSS Statistics for Windows, version 22 (IBM Corp., Armonk, N.Y., USA) has been used for all statistical analyses. A *p*-value of 0.05 or less was considered significant. All data were ordinal, and thus analysed with non-parametric tests with no adjustments for multiple comparisons. Descriptive statistics, such as frequencies, mean, standard deviations, percentiles, and confidence intervals, were calculated along with between- and within-groups comparisons (see below).

Power analysis

The power analysis was based on the outcome measure COPM (27). A sample size of 20 completed subjects was needed to detect a statistically significant difference for the primary outcome variable of 1.3 points and a standard deviation of 1.5 between treatment arms, with a power of 0.9 and alpha set at 0.05. Supplementary subjects were added to account for an expected statistical loss of at least 20%.

Effect size

The distributions of the test statistics were transformed into effect sizes (Cohens’ *d*) to describe whether achieved treatment effects have a sufficient magnitude. According to Cohen (32), 0.2 is considered a small effect, 0.5 medium and 0.8 large. This magnitude has subsequently been expanded by Sawilovsky (33) up to 2.0 and is dependent on the Gaussian densities.

Comparison between groups

The Friedman test (non-parametric alternative to 1-way analysis of variance (ANOVA)) was used for between-group analyses over the 3 measurement points for the AWP and the WAI. The Wilcoxon’s signed-rank test was used for comparison between the 2 independent samples and each measurement point. A 1-sample χ^2 test was performed to investigate the distribution of patients in the 4 WAI groups according to their work ability, based on the WAI Total Score. For comparison of the APT and the ABAT groups on the COPM and the RSAB, including 2 repeated measurement points, the Mann–Whitney *U* test was used.

Comparison within groups

The Friedman test was used for within-group analyses over the 3 measurement points for the AWP and the WAI. Wilcoxon’s signed-rank test was used for analysing differences at different time-points. The COPM and the RSAB, including pre-and-post measures, were analysed using Wilcoxon’s signed-rank test.

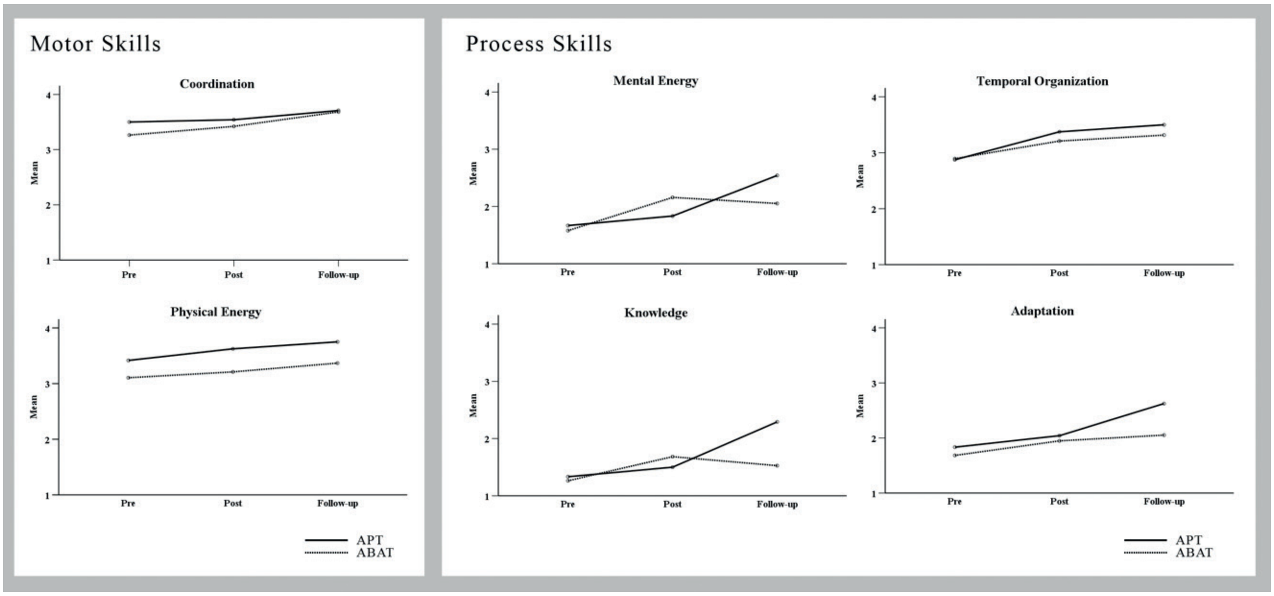

Fig. 2. Graphs of the Assessment of Work Performance (AWP) skills, where significant differences were found between the 2 intervention groups. The graphs are based on the mean values for each group at pre-, post- and follow-up assessments, where the y-axis values represent 1: deficient performance, 2: inefficient performance, 3: uncertain performance, and 4: competent performance.

RESULTS

Assessment of Work Performance

The AWP was used to evaluate the participants performance on the Structured Work Task Application AdRT. Friedman analysis of variance showed the following significant differences between the 2 treatment approaches. The APT group significantly improved Mental Energy (p=0.000, ES=1.84), Knowledge (p=0.003, ES=1.78), Temporal Organization (p=0.000, ES=1.43), Adaptation (p=0.001, ES=1.59) and Physical Energy (p=0.003, ES=1.21). The ABAT group showed significant improvement for Coordination (p=0.001, ES=1.49). Effect sizes were large. The improvement trajectories varied over time (Fig. 2).

Between-group analyses for each time-point showed significant improvements for the APT group for Mental Energy (pre-follow-up; p =0.000, post-follow-up; p =0.030), Knowledge (pre-follow-up; p=0.001, post-follow-up; p =0.038), Temporal Organization (pre-post; p =0.000, pre-follow up; p =0.001), Adaptation (pre-follow-up; p =0.017, post-follow-up; p =0.017) and Physical Energy (pre-follow-up; p =0.022). For ABAT, significant improvements were observed for

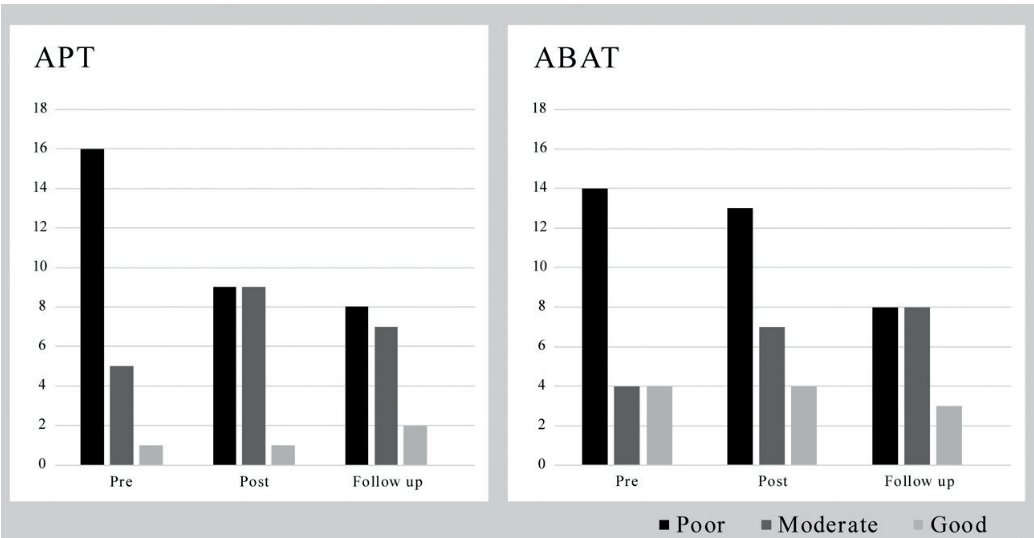

Fig. 3. Number of participants sorted into the 4 work ability groups in the WAI on pre-, post- and follow-up assessment. The groups were defined as: poor work ability (black) scores 7–27, moderate work ability (dark grey) scores 28–36, good work ability (light grey) scores 37–43, and excellent work ability scores 44–49. No participants rated their work ability as excellent.

Table II. Between-group analyses for selected activities using the Canadian Occupational Performance Measure (COPM) performance and satisfaction for the 2 treatment arms, Attention Process Training (APT) and Activity-based Attention Training (ABAT). Scores range between 1 and 10. Higher scores indicate better performance and satisfaction

	APT[a] Median	ABAT[b] Median	P[c]
Performance			
Pre-test	4.30	4.63	0.47
Post-test	6.13	7.00	0.34
Diff Pre-Post	1.17	2.00	0.37
Satisfaction			
Pre-test	1.80	3.00	0.08
Post-test	5.80	6.42	0.75
Diff Pre-Post	3.00	2.08	0.74

[a]Pretest: $n=31$, Posttest: $n=30$, Diff Pre-posttest: $n=29$, [b]Pretest: $n=28$, Posttest: $n=26$, Diff Pre-posttest: $n=26$, [c]Mann-Whitney Test (Asymp.Sig 2-tailed)

Mental Energy immediately after treatment (pre-post; $p=0.039$) and for Coordination (pre-follow-up; $p=0.002$, post-follow-up; $p=0.002$).

Work Ability Index

The distribution of the ratings of work ability is shown in Fig. 3. No participant estimated his/her work ability as "excellent" at any measurement point, and there were no significant differences between the 2 intervention groups at any time-point.

Canadian Occupational Behaviour Measure

Mann–Whitney *U* tests showed no differences between treatment groups on either level of occupational performance or satisfaction (COPM performance, $p=0.37$, and COPM satisfaction, $p=0.74$) (Table II).

Rating Scale of Attentional Behaviour

There were no differences between the APT and the ABAT groups in the total rating of commonly observed attention difficulties (Mann–Whitney *U* test t=–0.651, df=45, $p=0.52$).

Within-group comparisons to investigate the improvement pattern for each intervention are described below.

Within-group comparisons

The APT group improved significantly in their work performance during a structured cognitive demanding work task over time in Physical Energy ($p=0.048$, ES = 1.07), Mental Energy ($p=0.001$, ES = 2.49), Knowledge ($p=0.000$, ES=3.09), Temporal Organization ($p=0.002$, ES = 2.09) and Adaption ($p=0.021$, ES=1.26). The effect size showed large effects.

The ABAT intervention group improved significantly over time in Physical Energy ($p=0.042$, ES = 1.41), Coordination ($p=0.007$, ESv2.09) and Mental Energy ($p=0.016$, ES = 1.75). The effect sizes were large.

There were significant improvements pre-follow-up after the APT group intervention on the WAI Total Score ($p<0.001$, ES = 1.91), and Individual Resources ($p<0.001$, ES = 1.65) (see Table III). For the ABAT group, no significant improvements were seen; however, there was an improvement in Individual Resources

Table III. Within-group comparisons for the Attention Process Training (APT) and Activity-based Attention Training (ABAT) groups on the Work Ability Index (WAI) Total Score and every sub-dimension separately, showing mean and standard deviation (SD) at pre-post and follow-up assessment

		Mean (SD)		
		Pre	Post	Follow-up
WAI Total Score (range 9–59)	ABAT	25.2 (9.5)	26.7 (8.4)	26.9 (9.4)
	APT	24.9 (6.6)	26.4 (7.8)	28.2 (7.8)*
Individual Resources (range 6–41)	ABAT	17.6 (6.5)	18.3 (6.1)	19.0 (6.1)*
	APT	17.2 (5.7)	18.8 (6.3)	20.1 (6.3)*
a. Current work ability compared with life-time best (range 0–10)	ABAT	4.0 (2.6)	4.6 (2.6)	5.1 (2.4)*
	APT	3.8 (2.2)	4.3 (2.7)	5.6 (2.3)*
b_1. Work-ability in relation to physical demands in current work (range 2–10)	ABAT	2.2 (1.0)	2.2 (1.0)	2.6 (1.2)
	APT	2.1 (0.7)	2.4 (1.0)	2.4 (1.1)
b_2. Work-ability concerning mental demands in current work (range 2-–10)	ABAT	3.0 (1.6)	3.3 (1.4)	3.7 (1.6)
	APT	3.4 (1.7)	3.6 (1.5)	3.8 (1.5)
f. Expected work-ability in the forthcoming two years (range 1–7)	ABAT	5.5 (2.0)	5.1 (2.1)	4.9 (2.5)
	APT	5.4 (2.4)	5.1 (2.4)	5.2 (2.4)
g. Enjoy your regular daily activities (mental resources) (range 1–4)	ABAT	2.8 (0.8)	3.0 (0.9)	3.0 (1.0)
	APT	2.6 (0.9)	2.9 (0.9)	3.1 (1.0)*
WAI Individual Health Factor (range 3–18)	ABAT	7.9 (3.5)	8.3 (3.0)	7.8 (3.2)
	APT	7.7 (2.6)	7.7 (2.4)	7.8 (2.7)
c. Total number of medical diagnoses (range 1–7)	ABAT	3.3 (1.2)	3.2 (1.2)	3.1 (1.1)
	APT	3.2 (1.0)	3.2 (1.0)	3.5 (1.0)
d. Estimation of work impairment due to diseases (range 1–6)	ABAT	3.2 (2.2)	3.6 (1.9)	3.2 (1.8)
	APT	3.0 (1.7)	3.0 (2.0)	3.3 (1.8)*
e. Sickness absence during the last year (range 1–5)	ABAT	1.5 (1.1)	1.5 (1.3)	1.4 (1.3)
	APT	1.6 (1.1)	1.2 (0.7)	1.2 (2.4)

*significant improvement between post and follow-up assessment or between pre and follow-up assessment

($p=0.08$, ES=0.91). The effect sizes were large for the APT group. (For mean and SD see Table III).

Significant improvement was found between pre-and post-assessment for both intervention groups on both the COPM performance (APT: $p=0.001$, ES=1.85, ABAT: $p=0.001$, ES=1.84) and satisfaction (APT: $p=0.000$, ES=1.92, ABAT: $p=0.000$, ES=2.40) as well as for the impact of attentional impairment on the patient's everyday behaviour (RSAB Total Score: APT: $p=0.027$, ES=1.03, ABAT: $p=0.007$, ES=0.81). The effect sizes showed large effects on these measures.

In summary, the within-group comparisons showed that work performance, self-assessed work ability, performance and satisfaction in daily occupations had improved for both the APT and the ABAT groups. The measures targeting the patients' daily activities/everyday behaviour showed intermediate to strong effect sizes.

DISCUSSION

The aim of this study was to measure the effects of 2 different treatment approaches to improve attention for performance pertinent to activities of daily living and work ability. Differences between the 2 treatment groups were found for work performance on a structured attention-demanding work task (AWP) with a significant advantage for the APT group. This group improved significantly more in some relevant process skills, such as Mental Energy, Knowledge, Temporal organization, and Adaptation, with large effect sizes. The results also indicate that some skills improved earlier in the recovery process, and others later. Thus, the current results may indicate an advantage of systematic attention training by APT when analysing changes on the level of process skills requiring some type of complex attention.

These improvements occurred at different time-points. Immediately after treatment, no difference was seen between the 2 intervention groups, except for the AWP Process scale, indicating the importance of evaluating the effectiveness of intervention during a more extended period (11). For example, Johansson & Tornmalm (34) and Lundqvist et al. (35) found that patients with ABI receiving working memory training at follow-up assessment 4–6 months after intervention still experienced improved occupational performance in daily life.

These results, obtained by measures of separate performance skills, are in line with earlier positive results for attention training, measured by neuropsychological tests, reflecting the body function cognition (36, 37).

In the other, more global, measures of activity performance, the results were inconsistent.

The APT group rated an improvement in perceived work ability (WAI), but for COPM and RSAB, there were no differences between the 2 treatment arms. Both groups improved considerably. These results are in line with earlier studies concerning the total effect of interdisciplinary rehabilitation programmes, but no differential treatment effects could be discerned.

The improvements in COPM are in line with earlier studies (11) concerning the positive effect of interdisciplinary rehabilitation on daily activities in clinical practice (38), in community-based rehabilitation (39), and in telerehabilitation (40). Although an advantage of COPM is the individual selection of purposeful activities (41), there are some methodological disadvantages, such as difficulties in comparing the assessed situations in research studies or the influence of the participants' awareness (42). However, Jenkinson et al. (39), did not find any association between these variables and COPM in a study comprising a similar patient group.

The current study is the first to use the WAI to describe changes following rehabilitation after ABI. The APT group changed from poor to moderate work ability, i.e. a limited improvement, but WAI Total Scores were lower at follow-up, than the national survey sample (26). These results should be interpreted with caution, as they reflect self-report measures and not actual data from the registry of the Swedish Social Security Agency.

Both intervention groups showed substantial improvements on the RSAB Total Score. RSAB was based on daily observation of performance for 1 week by the patient's OT, and physiotherapist. Thus, type of activities, time of day, and environment for the daily observation, varied. Also, several raters performed the scoring, with a potential bias among raters (43). Perhaps, for studies concerning cognitive interventions, more sensitive instruments are needed to capture the change in attentional ability in everyday activities. RSAB was chosen as an outcome measure, as it been sensitive to change in previous rehabilitation trials (15, 29, 30). Overall, these methodological difficulties may have contributed to the present results.

Intensive targeted cognitive rehabilitation is an emerging area, with evidence to improve trained functions in specific cognitive areas (8, 44); however, the transfer effects of intensive targeted cognitive training on the levels of activity and participation are still debated (45, 46). A potential source of inconsistent results might be attributed to methodological issues and differences in focus. There are differences in the conceptual level between measurements of body functions, including cognitive tests, measurements of process skills and global measures of activity performance. Correlations are low to moderate between the 3 different levels of assessments (47).

The current study attempted to resolve this problem by selecting more targeted measures. For the AWP, we enhanced the sensitivity and specificity of the instrument by developing a standardized attention-demanding work task, the AdRT, as well as improving the accuracy of scoring criteria (22). We believe that this adaptation to the AWP was advantageous in obtaining favourable results concerning improvements in process skills after targeted cognitive rehabilitation. The WAI was used as a self-rating instrument, but the results included both subjective ratings and data (number of diagnoses) contributing to increased accuracy. The results of the positive effect of APT on perceived work ability and work task performance might partly be related to the higher sensitivity of the measurement tools. The measurements of daily activities, the RSAB and the COPM, were obtained for a wide range of activities. This fact, together with the methodological weaknesses of self-reporting, observational bias, expectancy effects, and other factors, might have precluded a fine-graded examination of possible differences between the 2 attentional training methods.

The strength of the current study is its focus on performance-based assessments to elucidate the effects of cognitive training on activity and participation. However, the diverging results also emphasize the importance of methodologically sound, rigorously defined outcome measures. Further methodological development is necessary for targeted studies of the specific effects of separate rehabilitation procedures, as also pointed out by Loetscher & Lincoln (7).

This study has several limitations, such as the restricted range of symptoms due to relatively strict inclusion criteria limiting generalizability. Some measures (COPM and RSAB) were performed only at pre-and post-assessment; hence long-term sustainability of the perceived improvements remains to be evaluated. Because of the nature of the intervention, it was not possible to blind treating clinicians or participants.

CONCLUSION

Significant differences were found favouring APT for some process skills (AWP). There were no discernible differences in global measures of activity between the 2 approaches, both groups improved significantly, as shown by the effect sizes.

We were able to uncover changes on an intermediate conceptual level, in performance skills, reflecting the utilization of a body function, i.e. attention in interaction between task and environment. However, the global measures used in this study appear to be conceptually distant from measurements of body functions obscuring the documentation of possible changes. There is a need to develop adequate measures for changes in performance skills to measure the effects of cognitive training on activity and participation after ABI.

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Appendix I. Work skills assessed in the assessment of work performance (AWP) (*n*=14).

Work skills	
Motor skills	
Posture	Ability to stabilize and position oneself with environment and task
Mobility	Ability to move one's body and body parts with the environment
Coordination	Ability to coordinate body parts movements with each other and the environment
Strength	Ability to use strength/handle objects in an appropriate manner
Physical Energy	Ability to perform and complete a work task within a reasonable time and without becoming physically exhausted
Process skills	
Mental Energy	Ability to perform and complete the work with maintained attention and without becoming fatigued
Knowledge	Ability to acquire, learn and use knowledge and tools and perform a work task according to aim and goal
Temporal Organization	Ability to initiate, continue, finish and perform task moments in a logical sequence
Organization of Space and Objects	Ability to organize workspace and tools
Adaptation	Ability to note/react, adjust behaviour and adapt to the environment as a reaction to perceptual or environmental performance cues
Communication and Interaction Skills	
Physicality	Ability to physically communicate and interact with other people
Language	Ability to use language for communication and interaction
Relations	Ability to provide communication and social fellowship with other persons
Information Exchange	Ability to exchange information with others

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