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**EVALUATION OF ATTENTION TRAINING  
AFTER ACQUIRED BRAIN INJURY  
- AN OCCUPATIONAL PERSPECTIVE**

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# Evaluation of attention training after acquired brain injury – an occupational perspective

## THESIS FOR LICENCIATE DEGREE (med.lic)

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## **ABSTRACT**

**AIM:** The aim of this thesis was to evaluate the effects of two different approaches of attention training, Attention Process Training (APT) and Activity-based Attention Training (ABAT) after ABI, on level of activity and participation. To be able to assess the effect of attention training on work performance, the aim of the first study in this thesis was to develop and validate a structured attention-demanding work task to be used as a task application for the Assessment of Work Performance (AWP). The second study in this thesis aimed to evaluate the effects of APT and ABAT in the sub-acute phase after ABI, on daily activity, work performance and perceived work ability.

**METHOD:** Study I was a methodological pre-study developing and validating a simulated work task, the Attention-demanding Registration Task (AdRT). 65 individuals with attention deficits due to ABI and 47 healthy individuals performed the task and the performance was analysed using the statistical method the Area Under the Receiver Operating Characteristic (ROC) Curve (AUC). In Study II, 51 participants with stroke or traumatic brain injury (TBI) 4-12 month-post injury were randomized to 20 hours of attention training with APT or ABAT. Effect in daily activity, work performance and perceived work ability was evaluated pre- and post-intervention as well as after three months.

**RESULTS:** The Structured Work Task application AdRT showed high sensitivity and specificity in differentiating between individuals with attention deficits due to ABI and healthy individuals when comparing performance of the work task. Therefore, in the following randomized controlled trial, the AdRT was used together with the AWP to evaluate the effect of attention training after ABI on actual work performance. Attention training after ABI resulted in significant improvements on measures of daily activity with strong effect sizes in both intervention groups. Furthermore, assessment with AWP showed that process skills in the group receiving APT continued to improve to the three-month follow-up. There to the WAI showed a moderate work ability at the follow-up for the APT group whereas the ABAT group maintained a poor work ability.

**CONCLUSIONS:** To assess work performance, the use of the Structured Work Task application AdRT, linked with the AWP, proved to be sensitive to attention deficits. Both approaches of attention training resulted in significantly improved performance in daily activity. Training with APT may have an additional positive effect on work performance and perceived work ability.

## **LIST OF SCIENTIFIC PAPERS**

- I. Is a structured work task application for the assessment of work performance in a constructed environment, useful for patients with attention deficits? *Disability and Rehabilitation*. 2019:1-11.
- II. Comparing Attention Process Training and Activity-based Attention Training after acquired brain injury. A randomized controlled study. 2020; Submitted for publication in the *Journal of Rehabilitation Medicine*.

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## **LIST OF ABBREVIATIONS**

ABI	Acquired Brain Injury
ABAT	Activity-based Attention Training
AdRT	Attention-demanding Registration Task
APT	Attention Process Training
AWC	Assessment of Work Characteristics
AWP	Assessment of Work Performance
COPM	Canadian Occupational Performance Measure
CG	Comparison Group
OT	Occupational Therapist
PG	Patient Group
PT	Physiotherapist
RCT	Randomized Controlled Trial
RSAB	Rating Scale of Attentional Behaviour
TBI	Traumatic Brain Injury
WAI	Work Ability Index



# 1 INTRODUCTION

This thesis is part of a larger, and prospective randomized controlled trial (RCT) of 120 consecutive patients with acquired brain injury (ABI) (1). This extensive RCT study aims to examine rehabilitation of attention in the acute (<4 months) and subacute (4–12 months) rehabilitation phases after stroke or traumatic brain injury (TBI). The intervention effects are evaluated on level of function, activity, and participation. In this thesis, the focus is on the effect of attention training in the subacute phase after ABI on activity and participation in daily life.

To be able to assess the effect of attention training on work performance, the first study describes the development and validation of an attention-demanding structured work task, the Attention-demanding Registration Task (AdRT) to be used with the Assessment of Work Performance (AWP). The second study in this thesis is an RCT study evaluating the effect of two different approaches of attention training on performance in daily activities and perceived work ability.

## 1.1 ACQUIRED BRAIN INJURY

ABI is an injury that usually occurs abruptly, for example in case of external violence, stroke, tumours, infection, and lack of oxygen. In Sweden about 50.000 individuals annually survive ABI. The two largest diagnostic groups with ABI are stroke (2) and TBI (3). Brain injury may lead, depending on injury characteristics, to residual symptoms such as motor, cognitive, emotional, and behavioural deficits (4, 5).

### 1.1.1 Type and prevalence

Stroke affects about 25.000 individuals each year out of which 20% are in working age (6). Stroke is a result of circulatory failure causing a focal or global impairment of functions associated with the affected area. The brain damage is caused by impaired blood supply to the brain or burst of blood vessels in the brain (7).

TBI is a result of an external impact to the head that leads to contusions, hematomas and diffuse axonal injury (3). Approximately 22.000 individuals in Sweden each year suffer a TBI out of which half require hospitalization (8). The most common causes of TBI include violence, transportation accidents and recreation activities/sports (9). TBI is classified in order of severity depending on duration and level of altered consciousness, and influence on cognitive or motor problems at the time of injury (3). However, the classification of severity does not necessarily correspond to the degree of disability, as even a mild TBI may result in long-term impairments (10).

### 1.1.2 Residual cognitive disabilities and activity limitations

Cognitive disabilities after ABI and its consequences, with specific focus on the cognitive function attention, are focus for this thesis. Central cognitive disabilities after ABI are attention- and memory deficits, diminished self-awareness, reduced mental speed, fatigue and

executive dysfunction (11). Residual cognitive impairment often results in wide-ranging activity limitations and reduced participation in everyday life situations. Reduced ability to perform household- and leisure activities inside or outside the home and decreased working capacity are often reported (12-15). Frequently experienced difficulties are manage personal finances, cooking, shopping, and attending courses, sports or cultural events (15). Changed life satisfaction and social roles are common in the long term (12-14).

### **1.1.3 The cognitive recovery**

After a brain injury in adult age, changes in brain activity involve both degenerative and reparative processes over the following weeks and months (16). A great deal of the spontaneous recovery of function following ABI happens within the first three to four months after stroke (7) and within the first six months after TBI (17).

There may be a great variability in the recovery process between individuals, where symptoms and rate of cognitive recovery do not necessarily correspond to the degree of brain pathology (18). Known predictors of outcome are factors such as age, gender, diagnosis, injury severity and rehabilitation interventions (9, 16, 19). The recovery process after ABI may be enhanced through rehabilitation interventions by which the individual relearns functions impaired by injury or learns compensatory behaviour for lost function. Professional rehabilitation interventions have also been shown to reduce the risk of maladaptive plasticity in “self-taught” behavioural changes (7, 18, 20).

## **1.2 COGNITIVE REHABILITATION**

Cognitive rehabilitation refers to interventions aiming at improving cognitive ability and thereby increasing participation in daily life activities (21). Effective cognitive rehabilitation of adults in working age normally requires multi-disciplinary teams, including a wide range of professionals, to enable and support the re-learning of functions and adjustment of performance and behaviour in daily life (22).

Cognitive interventions methods are either aimed at compensating for lost function or aimed at restoring function. Compensatory interventions primarily aim to correct the symptoms rather than the cause of the difficulties, while restorative interventions focus on improving function through direct training of the impaired function. In parallel with specific restorative and compensatory interventions, training also usually takes place in daily activities, enabling the individual to discover their limitations and find strategies to adapt to a new life (23).

Specific compensatory interventions methods include both support in the process of adapting to deficits such as teaching ways to simplifying activity requirements or optimizing the use of remaining strengths, and support in choosing and using appropriate strategies to manage everyday tasks (23, 24). Remediating interventions focus on a specific function and uses progressive increment in task difficulties to make it possible for the individual to gradually resumes his/her abilities (25). These interventions are usually combined with metacognitive strategies aimed at making the individual more aware of his/her ability and how to

overcome difficulties in daily living (26). Remediating interventions have shown good potential to improve the individual's performance and decrease activity limitations (21, 22, 27).

### **1.2.1 Occupational-based cognitive rehabilitation**

Occupational therapists (OT) are an integral part of the rehabilitation team and specialized in the analysis of human function and restoration of performance in everyday activities (28). In general, OT's use activity-based training and compensatory strategies to improve performance in cognitively demanding activities (28, 29). Occupational therapy interventions are specially adapted to promote re-education of lost skills. The remediation of motor, sensory, and cognitive deficits is promoted by giving the patient the opportunity to enhance different performance skills in activity until an appropriate level of performance is achieved (28). A meta-analysis by Park 2014 (29) has shown that occupational-based cognitive rehabilitation results in positive effects on cognitive functions and occupational performance in patients with ABI. Regardless of the initial level of cognitive function, more time spent in cognitively demanding activities, such as activities requiring problem-solving, memory, math, or money management, have been associated with better outcomes in terms of length of rehabilitation stay, higher likelihood of discharge to home, and functional status at discharge and nine months' post-discharge (30).

### **1.3 OUTCOME ASSESSMENTS IN COGNITIVE REHABILITATION**

Outcome in cognitive rehabilitation is usually evaluated with various imaging techniques, psychometrical testing and evaluation of activity and participation through self-assessment forms and performance-based assessments (23, 27, 31). A growing body of evidence indicate that performance-based instruments may be a more accurate means of predicting or determining abilities in daily life, work ability and work return (32-35). This, as the individual may not perform as well in real-life situations with distractions and unpredictable task demands through the course of a day, than in an artificial, quiet, distraction free environment (34).

The purpose of performance-based assessments is to identify the individual's present physical, behavioural and cognitive abilities or limitations in relation to actual task demands (34). Through performance-based assessment the occupational performance is analysed in terms of different performance skills through bridging the gap between body functions and performance in daily living (36, 37).

Performance skills are the observable actions that the individual carries out and that contribute to effective execution of daily tasks (38, 39). Although not intended to evaluate the same level of function as global measures of activity performance or test of body functions, low to moderate correlations has been found between the three different levels of assessments (40-44). Highest correlation between cognitive function and performance in activity has been found for visuomotor organization, thinking operations (44), auditory vigilance attention, visuo-spatial perception and visual scanning (43).

One of the difficulties in evaluating the effect of cognitive rehabilitation on performance of daily living is that the relative difficulty of a selected evaluation task affects the individual's performance (33). Therefore, linear measures of work performance can only be generated between testing sessions and/or different individuals if tasks with same challenge are used (33).

A potential weakness of performance-based instruments is that they require a high degree of inter-consistency rater judgment (45). Research shows that the rater's knowledge and beliefs about the task and the rating procedure may influence examinee scores. Raters may apply scales in an inconsistent manner, overuse some parts of a rating scale, or have a tendency to give higher or lower ratings than the individual should receive on the basis of their actual performance (46). Moreover, there can be difference in rating not only between raters, but also within raters due to mood or knowledge changes over time (47). Therefore, specific criteria for normal performance in terms of performance speed and quality of the performance are needed to more objectively measure the quality of an individual's work performance (48).

## **1.4 WORK ABILITY AFTER ACQUIRED BRAIN INJURY**

Sick-leave and its consequences are considered as personal and public health burdens. Work return rates for individuals with ABI have in previous research shown to lie between 30–65% of employees returning to work, with a mean of 40% returning within two years after the injury (49, 50). Individuals who have been able to return to work after ABI report an improved wellbeing, greater social integration, better health status and a better quality-of-life (50, 51). As individuals with ABI often experience difficulties regarding returning to work, this is often an important rehabilitation goal (50, 52).

### **1.4.1 Assessment of work ability**

Work ability can broadly be defined as having the health, work-related competence (acquired knowledge and performance skills) and occupational traits that are required for managing different work tasks (48, 53) and reach the goals that typically can be reached in a specific work place or profession (48). To define an individual's work ability, it's necessary to specify some kind of standard for what the individual should be able to achieve in a certain environment (53, 54).

Sandqvist (2004) has in a conceptual framework (39) defined three different levels of work ability assessments: society level (work participation), individual level (work performance) and body level (individual capacity) (48). As the work ability may change over time and between situations, the assessment also needs to consider the effects of environmental and temporal factors (33, 39).

There is a great variability in how work evaluations are completed in practice (25, 33, 55) both regarding time frame for the assessment and assessment tools used (55-57). A majority of current available work assessments evaluate physical or mental body functions and/or work capacity using different physical tasks (33). Some are based on specific oral or written

questions to assess general work ability (58) or to identify potential barriers to work return (59) such as the Work Environment Impact Scale (WEIS) (60) and the Worker Role Self-assessment (61). Only a few available work assessment tools can be used to measure actual performance in specific work tasks (33), or be used to evaluate the individual in a variety of simulated work activities for a period of a couple of days (62). The Valpar Component Work Samples (VCWS) (number 1 to 11) is one performance-based work assessment method that uses Methods-Time-Measurement (MTM) to establish industrial work rate standards (63). This system has rarely been used in Sweden. Another performance-based assessment method for standardized evaluation of working skills are the Assessment of Work Performance (AWP) (33). The AWP is developed for use in work related tasks most relevant for the individual and therefore does not include standardized evaluation tasks.

Today only one performance-based assessment, the Assessment of Motor and Process Skills (AMPS) (64) includes standardized tasks. However, AMPS only has standardized personal care and instrumental tasks such as making an easier meal and ironing (33). Therefore, there are currently no existing performance-based assessment that include cognitively demanding standardized work tasks (33).

In the absence of methods to objectively measure the individual's task performance, it is essential that the examiner has work-related performance criteria of normal performance in terms of reaching goals, performance speed and quality for the target task. Thereto, the same task needs to be used to be able to validity compare scores between testing sessions or across different individuals (33).

The lack of standardized work tasks in research is a measurement challenge as performance in activities is primarily a question of the balance between a person's resources and activity demands (65). This is probably one of the reasons why there's a lack of studies examining the effectiveness of cognitive training with performance-based assessments on activity and participation in society after ABI. There is especially a lack of studies examining the effect of cognitive training on work performance, work return and ability to remain in work after ABI (4, 11, 66).

## **1.5 ATTENTION**

The term 'attention' refers to the brain's ability to focus on selected information and ignoring distractions, our ability to shift focus from one thing to another when needed, and to do two things at the same time (67). Several theoretical models within fields such as cognitive psychology (68), neuropsychology (69) and neurophysiology (70) have been developed to better understand and describe factors related to this ability. On neural level our ability to attend is the product of multiple interacting processes requiring different neural resources depending on the target of focus or situational demands (71, 72). However, to better understand attentional components the function is often described based on its recognized manifestations into daily life. The attention function is to clinicians and patients then

commonly divided in five levels; focused, sustained, selective, divided and alternating attention based on Sohlberg & Mateer's clinical model of attention (73):

- ❖ Focused attention refers to the ability to recognize specific sensory information.
- ❖ Sustained attention is the ability of keeping focus during an activity including working memory and mental control.
- ❖ Selective attention refers to the brain's ability to prioritize or select some stimuli over others while inhibiting non-target information.
- ❖ Divided attention refers to our ability to simultaneously respond to two (or more) stimuli, such as engage in a conversation while driving.
- ❖ Alternating attention is the ability to shift focus between tasks without losing focus from the task at hand.

### **1.5.1 Attention deficits**

Attention deficit is a common cognitive symptom after ABI resulting in difficulties such as distractibility, reduced performance speed and fatigue (74, 75). Relatively small deficits of attention may have a significant impact on daily life by affecting learning skills, performance and participation in social life (67). Specifically, the occurrence of impaired memory and attention after ABI has been shown to correspond to difficulties returning to work (4).

Improving attention is often one of the main goals of the rehabilitation process (76). Interventions primarily focusing on remediation of attention deficits uses repetitive training with exercises focusing on isolated processes of attention and exercises with progressively increased challenge (21, 27, 77). Today, the remediating training program Attention Process Training (APT) (73) and the n-back procedure are recommended in combination with meta-cognitive strategies targeting deficits in self-monitoring in the post-acute phase after ABI (21, 27, 78). Thereto, Time Pressure Management is recommended to avoid attention overload using specific metacognitive strategies to increase planning ability (79). Training of attention while using computer-based interventions are only recommended with the addition of clinician-guided feedback and strategy training (27).

The APT has been found to be a successful intervention to improve attention function remediation after ABI in the late phase after ABI (80) resulting in improved attention (80-82) and executive function (80) and decreased cognitive difficulties in daily living (81). Therefore, the APT is in the post-acute stage after TBI considered as the golden standard for treatment of attention deficits (27) and considered as standard practice in cognitive rehabilitation by the American Congress of Rehabilitation Medicine (83). However, research studies that target improvements in daily activities and work ability are scarce for comparing different approaches of attention training after ABI. The effect of attention training on work performance and work ability has not been investigated, despite the overwhelming evidence of the importance of cognition or attention for the possibility to work (4, 11, 84-87).



## **2 AIMS**

The main aim of this thesis was to evaluate the effect of two different approaches of attention training, APT and ABAT in the sub-acute phase (i.e., 4-12 month) after ABI on daily activity, work performance and perceived work ability.

### **2.1 STUDY I**

The aim for study I was to develop an attention-demanding work task to be used as an evaluation task in study II when comparing treatment effect of two different approaches of attention training after ABI. The aim was to examine how well the task discriminates between individual's with attention deficits due to ABI and healthy individual's without attention deficits, and to investigate the specificity and sensitivity of the evaluation task when used as a task application for the AWP.

### **2.2 STUDY II**

The aim of the principal RCT study II was to compare the effect of two different cognitive rehabilitation approaches, process-oriented attention training, the APT, and activity-based attention training, the ABAT, in the sub-acute phase after ABI on level of activity and participation.



### 3 METHODS

#### 3.1 OVERVIEW

Study I was a methodological study describing the development and validity of a structured work task application for use with the AWP (88) in a constructed environment. Study II was an RCT study using two groups focusing on type of intervention (APT or ABAT). For an overview of research aim, design, data collection, measurements and analysis methods see Table 1.

*Table 1. Overview of research aim, study design, methods of data collection, assessment and analysis used in the two studies*

Study	I	II
<b>Aim of research</b>	To develop an attention-demanding Structured Work Task application for the AWP and to investigate the sensitivity and specificity of the task to discriminate between healthy individuals and patients with attention deficits due to ABI.	To compare the effect of two different approaches of attention training, APT versus ABAT, on activity and participation.
<b>Study design</b>	Methodological and descriptive	Randomized Controlled Trial
<b>Participants</b>	Patients (n=65) with stroke or TBI > 4-month post injury and a comparison group of healthy working individuals (n=47)	Patients (n=51) with stroke or TBI 4-12-month post injury randomized to APT or ABAT
<b>Data collection</b>	The Structured Work Task application for the Assessment of Work Performance (AWP) and the Assessment of Work Characteristics (AWC)	The Assessment of Work Performance (AWP), the Rating Scale of Attentional Behavior (RSAB), the Canadian Occupational Performance Measure (COPM) and the Work Ability Index (WAI)
<b>Methods of data analysis</b>	Descriptive statistics (mean, median, 95% confidence interval, IQR), cronbach's alpha, Mann Whitney U test, t-test, parametric data, the Area under the Receiver Operating Characteristics (ROC) curve (AUC) analysis	Descriptive statistics (frequencies, mean standard deviation, percentiles, confidence intervals), effect size with Cohen D, Friedman test, Mann Whitney U test, Wilcoxon Signed Ranks test and Chi square tests

#### 3.2 POWER ANALYSIS

Power analysis was based on the outcome measure the Canadian Occupational Performance Measure (COPM) (89). 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%.

### 3.3 PARTICIPANTS

The studies were carried out at the Department of Rehabilitation Medicine, Danderyd University Hospital, outpatient unit, for patients with ABI.

A consecutive series of patients (n=65) at least four months post stroke or TBI were included in Study I. Further, 47 individuals working in different areas at the hospital were recruited as a comparison group (CG) through distribution of information about the study. In Study II, 51 of 65 patients included in Study I participated. Of the 65 patients, seven were excluded due to ABI more than one-year ago and seven due to early discharge. See Table 2 for demographic data for the participants in Study I and II.

#### 3.3.1 Patient inclusion criteria

- Stroke or TBI > 4 month post injury/disease
- Age 18-60 years
- Attention deficits as based on the diagnostic test in the APT method (90). Cut-off scores 70% or less on at least two of the subtests
- For abstract thinking and reasoning skills, scores from the lower average and above (scaled score  $\geq 7$ ) from Matrix (WAIS-III) were used (91)

#### 3.3.2 Patient exclusion criteria

- Neglect, cutoff  $\geq 2$  omissions, as measured with Albert's test (91)
- Ongoing substance abuse, psychiatric illness or severe pain
- Aphasia, visual impairments or severe bilateral motor impairments that made participation impossible (carry out assessments/interventions)

Table 2: Demographic data for the participants in Study I and II

Study	I		II	
	Comparison group	Patient group	APT	ABAT
<b>Participants (n)</b>	47	65	25	26
<b>Gender (n; F/M)</b>	31/16	36/29	17/8	13/13
<b>Mean age (yrs: range)</b>	42.7 (22-60)	47.7 (24-60)	46.6 (9.6)	49.9 (8.9)
<b>Diagnosis TBI/stroke (n)</b>		15/50	5/20	7/19
<b>Time since injury (days) (mean/SD)</b>		252.1 (199.2)	184.2 (66.7)	174.6 (56.1)

### 3.4 PROCEDURE

The participants were recruited to an RCT study of intensive cognitive rehabilitation four-month post-ABI. Computerized screening logs were used to follow patients during the recruitment process. Medical records were screened weekly to identify potential study participants.

Patients fulfilling basic inclusion criteria (stroke or TBI, age 18-60 years) underwent clinical assessment to verify inclusions and exclusion criteria (1). Participants that fulfilled all inclusions criteria received information according to the Declaration of Helsinki regarding their participation. After giving written consent of participation, the participants underwent baseline assessment by OT and physiotherapist (PT). The inclusion process for patients in study I and II is presented in Figure 1.

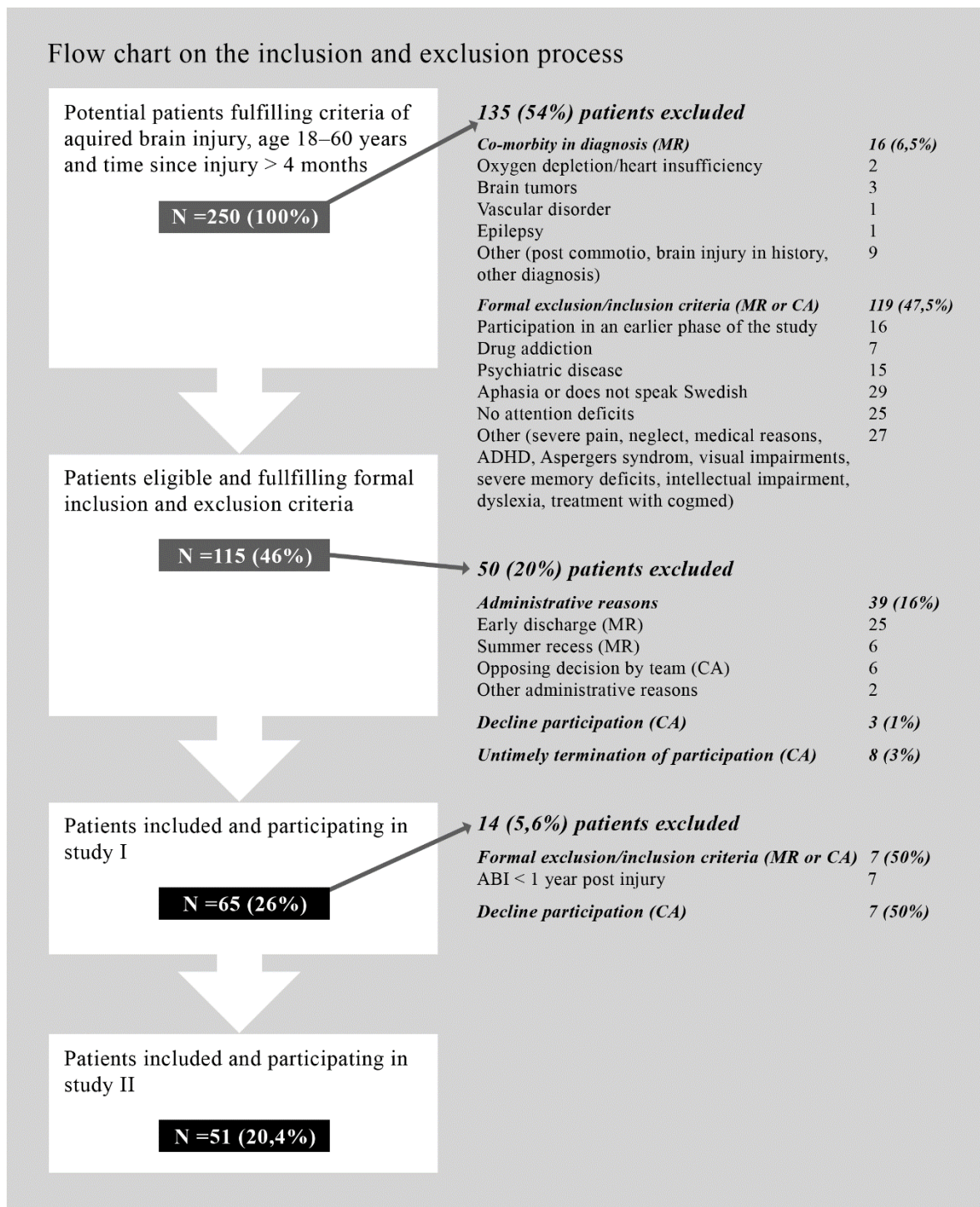


Figure 1: Flow chart for inclusion and exclusion of study I and II based on medical records (MR) and clinical assessment (CA). Values are expressed as number and percentage of total number of patients.

After inclusion the participants were randomized to one of two interventions, APT (90, 92) or ABAT. Sealed consecutively numbered opaque envelopes containing treatment allocations recorded on a piece of folded paper was used for randomization. Administration of the envelopes was controlled by one senior researcher outside the research program. The top envelope was opened by the first author every time a new patient was included in the study.

### 3.4.1 Study I

Study I was carried out with the purpose of creating a structured attention-demanding evaluation task for the RCT (study II) with the aim to evaluate the effect of attention training on work performance after ABI. The process was initiated by identifying a task, which is relevant to most workplaces in post-industrial countries and constitutes high demands on attention for accurate performance. Since no work task was found in a literature review, a computer-based registration task, the AdRT, already in use in a non-standardized form in the rehabilitation clinic, was chosen for further development.

AdRT consists of transfers of information to a data file from handwritten name plate orders after an instruction. To standardize the assessment procedure, a manual was created consisting of information about appropriate assessment environment and instructions to be given before/during the performance of the AdRT. Performance data in terms of number of errors and performance time was collected from a healthy CG without attention deficits, to obtain reference values for normal variations in the performance of the task (48). Thereafter the CG performance in terms of accuracy and execution time was calculated in percentiles, the higher percentile the poorer performance in terms of longer execution time or higher numbers of errors. Finally, accuracy and performance time was linked to the AWP assessment levels 1-4, thereby standardizing assessment of performance to the scoring of the AWP. The aim of this revised AWP scoring was to provide guidance

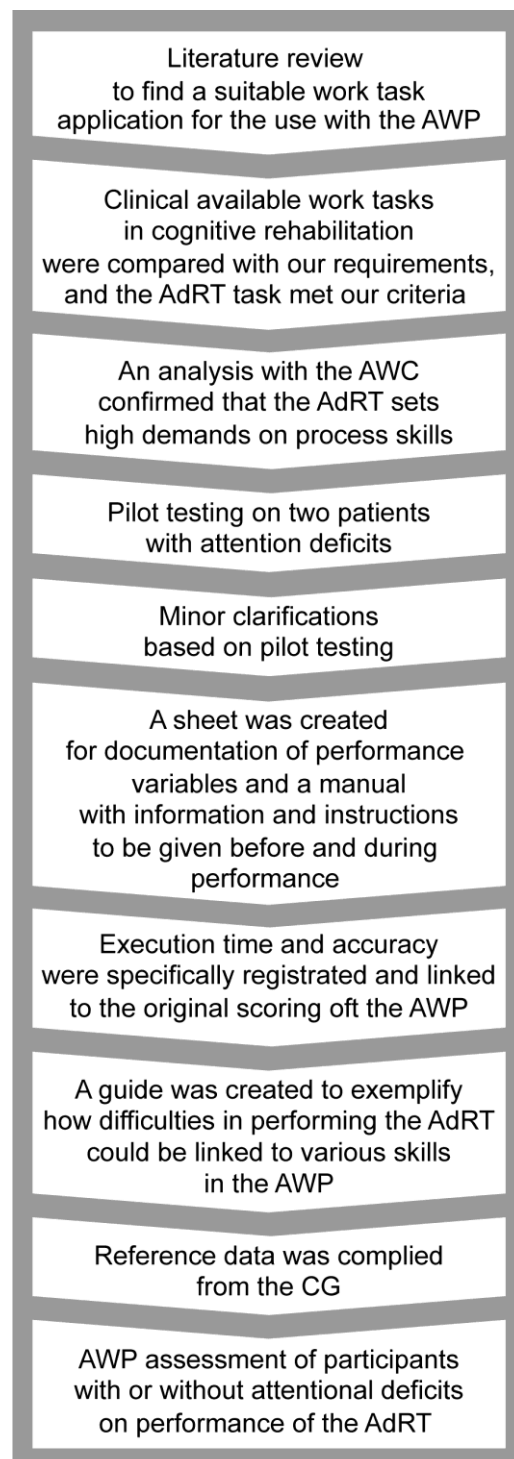


Figure 2: The flow chart of the developmental process the AdRT

for the scoring of motor and process skills. The use of the performance measures number of errors (accuracy) and performance time was assumed suitable since patients with attention deficits often have difficulties in this area (93-95). The detailed flow chart of the developmental process of the AdRT is described in Figure 2.

### 3.4.2 Study II

The intervention trial was carried out as a part of the regular interdisciplinary rehabilitation program the patients participated in. However, the participants were not allowed to engage in other similar intensive process-oriented cognitive training methods such as Cog Med QM (<https://www.cogmed.com>) until post-training assessment had been completed.

Within two weeks of pre-test assessment, all patients started the intervention period consisting of 20 hours of attention training using APT or ABAT, two to five days a week, for a period of three to six weeks. Treatment started at average 6 months (min-max 4-11,5 months) post-injury. Post-assessment was performed within two weeks after the completed training period. Three months after post-assessment a follow-up assessment was carried out. See Figure 3 for the timeline overview.

Due to the nature of the rehabilitation procedure, neither rehabilitation professionals nor participants were blinded to type of intervention each patient received. Individual APT sessions were administered by three OTs, including the author of this thesis, and a neuropsychologist, and lasted 30-120 minutes depending on the individual patient's need. The ABAT was administrated by the OT responsible for the ordinary occupational therapy parts of the outpatient rehabilitation program. This OT was responsible for the content and implementation of training in attention-demanding activities and other OT intervention actions needed due to the participant's attention deficits. Time devoted and type of training at each session was individually registered. Each training session typically lasted 60-120 minutes.

### 3.5 INTERVENTION PROGRAM

All participants participated in a CARF accredited interdisciplinary rehabilitation program for adults in working age suffering from ABI. In addition to this they were randomized to two intervention programs for the remediation of attention deficits which were compared: structured intensive attention training with the APT I-II (73, 96) versus training in attention-demanding activities of daily life (ABAT). Each of the intervention programs included 20 hours of additional training as compared to rehabilitation as usual.

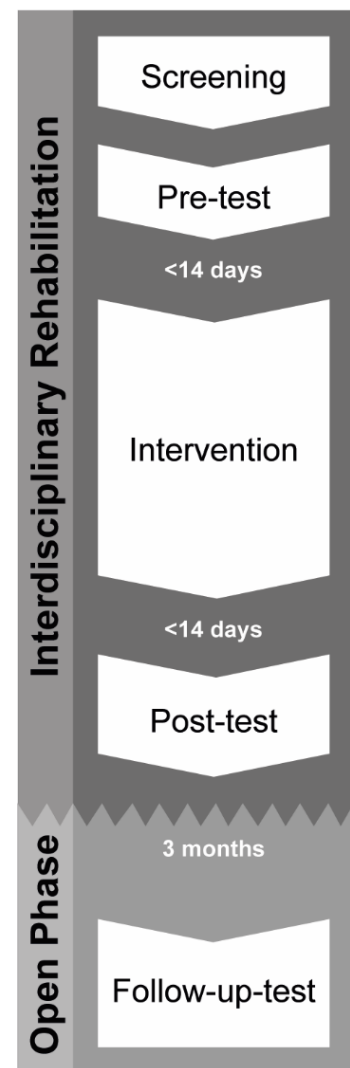


Figure 3: Timeline of Study II



### 3.5.1 Attention Process Training I-II (APT)

APT (73, 96) is an individualized, hierarchically structured intervention program designed to remediate attention deficits by structured, intensive and repetitive training of the underlying processes of the attention function. The program is organized after Sohlberg & Mateers clinical model of attention and uses a hierarchy of tasks administrated from basic to more complex tasks as the patient's ability improves (73). Exercises consists of visual and auditory tasks (separately or combined) that usually take three to five minutes to complete. Progress of training is made through intensive training of attention-demanding tasks, successful use of metacognitive strategies (management of attention deficits and generalization to other attention-demanding tasks in everyday life) and continuous feedback regarding speed of performance, endurance, and accuracy. When the performance improves, task difficulty and complexity is increased and/or tasks focusing on different components of attention is used (73). See Table 3 for examples of exercises and generalization tasks in daily living for the separate attention levels of APT.

### 3.5.2 Activity-based Attention Training (ABAT)

The ABAT was based on core occupational therapy (29, 97-100) with primary focus on reducing attention-specific activity limitations, as identified by an OT during evaluation. The training involved everyday activities which, in relation to the patient's current ability, set sufficiently high requirements on attention. Types of training and time devoted to a specific training procedure were individually registered.

The research team provided the OTs with examples of suitable training activities (Table 4). Training sessions lasted 45-120 minutes and consisted of both individual activities, such as reading and computer-based exercises, and group-based interventions, such as preparing food and participating in meetings. Compensatory strategies were chosen on an individual basis and could consist of taking frequent breaks, using notebooks and verbal self-guidance.

*Table 4: Examples of attention-demanding activities proposed as training activities in ABAT*

<b>Attention training in activities of daily life</b>		
Prepare a presentation	Planning tasks	Advanced puzzles
Participate in a meeting	Preparing food	Grocery shopping
Take notes during a lecture	Pay bills	Listen to/read books
Socialize in a cafeteria	Cooking	Computer work



Table 3: Examples of exercises and generalization tasks in daily living for the separate attention levels of APT

Attention level	Exercise from the APT material		Ex. of generalization to task in daily life
	Lower task complexity	Higher task complexity	
<b>Focused attention</b>	Strike over number one and six on a paper filled with different numbers	Listen to a serie of numbers. Press the button each time two numbers in a row are read where the second digit is one smaller than the digit read just before	Watch TV, listen to music, sort socks, empty the dishwasher, pay bills, and proofread text
<b>Sustained attention</b>	Count backwards: 95 minus seven. Contuine subtracting seven from each new amount you calculate	Reorder the words in a sentence consisting of six words in alphabetical order	Read literature, write a report, work with school material, plan food purchases or recalculate recipes
<b>Selective attention*</b>	Lighter auditory or visual background distractor (e.g. recital of numbers or work in an environment where people move around), while engaging in a task of sustained attention	Demanding auditory or visual background distractor (e.g. have the duty to ignore interesting distracting discussions or radio programs), while engaging in a task of sustained attention	Read literature or write a report and at the same time ignore distractions such as people speaking or moving around in the near environment
<b>Divided attention</b>	Listen to a series of letters. Press the button every time you hear the letter K. At the same time, strike over number six and nine on a paper filled with different numbers	Listen to a recital of month. Press the button for each month that comes chronologically before the previously mentioned month. At the same time, strike over number one and nine on a paper filled with different numbers	Make dinner with dessert, write notes during a lecture or cycle in a busy environment
<b>Alternating attention</b>	Listen to a series of digits. Press the button for even numbers. After the signal, press the button for odd numbers. Continue alternating focus for each signal	Listen to a series of digits. Press the button for numbers that is even divisible with three. After the signal, press the button for number that is even divisible by two. Continue alternating focus for each signal	Work with a project with breaks for new sms, mail or phone calls or perform household tasks with breaks when family child members needs help

\* same tasks as in training of sustained attention, albeit with various levels of distractions

## **3.6 ASSESSMENT INSTRUMENTS**

### **3.6.1 The Assessment of Work Performance (AWP)**

The AWP (88) is a performance-based assessment of an individual's ability to perform actual work tasks. The AWP was in these studies used to assess the participants performance of the task application AdRT.

In recent years AWP has become a frequently used assessment instrument within work rehabilitation settings in Sweden (101). The instrument is developed from an occupational therapy perspective and is based on a theoretical model, the Model of Human Occupation (MOHO) (102). The AWP is also related to a conceptual framework for assessment of work functioning (39).

The AWP assesses how efficiently and appropriately, the individual performs a work task in a work situation selected according to the examinee's individual experiences and needs. Fourteen skills in three domains are evaluated: motor skills (observable actions used to move the performing person or an object) (n=5), process skills (observable actions used to organize and adapt sequences of action to complete an activity) (n=5) and communication and interaction skills (observable actions used to communicate intentions and needs and to coordinate social behaviour to interact with people) (n=4).

The AWP skills are rated on a Likert-type scale in terms of: 1 = deficient performance, 2 = inefficient performance, 3 = uncertain performance, and 4 = competent performance. Items impossible to assess or found irrelevant by the user, is marked as 'lacking information' or 'not relevant' (88).

The AWP has sound psychometric properties concerning content-, construct-, face- and social validity, internal consistency and utility (88, 101). A recent study investigating the psychometric properties of task applications for the AWP indicated utility and social content validity for the work tasks used (103).

### **3.6.2 The Assessment of Work Characteristics (AWC)**

The AWC (104) used in study I is an observational instrument that evaluates the same performance skills as the AWP, but from the point of the currently evaluated task. The AWC estimates the demands of specific skills when performing a work task and analyses to what degree an individual needs to use different skills to perform a task efficiently and appropriately (104). The 14 skills are individually and numerically rated on a four-point Likert-type scale and (1) indicates that the performance skill is never needed for appropriate and effective performance of the selected task, (2) that the performance skill is needed occasionally, (3) that the performance skill is needed frequently and (4) that the performance skill is needed continuously (104). Initial testing of the AWC has shown good utility and content validity (105, 106).

### **3.6.3 The Work Ability Index (WAI)**

The WAI (107) measures work ability in following seven dimensions; a. current work ability compared with life-time best (score 0-10), b1/b2. work ability in relation to mental and physical demands in current work (score 2-10), c. the total number of medical diagnoses (score 1-7), d. estimated work impairment due to diseases (score 1-6), e. sickness absence during the last year (score 1-5), f. expected work ability in the forthcoming two years (score 1-7), and g. enjoy regular daily activities (mental resources) (score 1-4).

The dimension scores can be summed to a total score for the WAI (range 7-49) and then grouped into four categories 1. "Poor" work ability, a score of 7–27 (need to restore work ability), 2. "Moderate" work ability, a score of 28–36 (need to improve work ability), 3: "Good" work ability, a score of 37–43 (need to support work ability), and 4: "Excellent" work ability, a score of 44–49 (need to maintain work ability) (108).

The psychometric properties of the WAI showed to be satisfactory (108). Studies have associated poor WAI score with an increased risk for a disability pension or long-term sickness absence (109, 110).

### **3.6.4 The Rating Scale of Attentional Behaviour (RSAB)**

The RSAB (74) is used to assess the impact of attentional deficits such as distractibility and reduced alertness, processing speed and dual tasking (111) on everyday behaviour. The maximum score is 56 and lower scores imply better performance. The RSAB includes 14 item/behaviours which are scored on a 5-level Likert-type scale (0 = not at all; 1 = occasionally; 2 = sometimes; 3 = almost always; 4 = always). Scoring was performed jointly by the patient's OT and PT before and after the intervention period.

### **3.6.5 The Canadian Occupational Performance Measure (COPM)**

The COPM (112) assesses self-perceived occupational performance. Through a semi-structured interview, five main problems in the areas of self-care, productivity, and leisure are identified. For each issue, two scores are obtained, one score for deficits in occupational performance and one for satisfaction with performance in everyday activities. Higher ratings reflect higher performance, importance, and satisfaction. According to the manual, a change of two or more points are considered clinically relevant (112).

Research and clinical literature reviews conclude that COPM is a valid, reliable, clinically useful, and responsive outcome measurement (113). The utility of COPM in community-based ABI rehabilitation has shown significant improvements in most COPM ratings. Importantly, no significant association has been found between COPM ratings and mood state, awareness, and cognitive function (114).

## **3.7 STATISTICAL METHODS**

For statistical analysis, the SPSS for Windows version 22.0 was used. Significance was set at 0.05. Data was controlled for skewness and kurtosis and analysed with non-parametric tests.

Non-parametric and parametric statistical methods were used for demographic and injury-related data. Demographic and injury related nominal data such as diagnosis, gender, profession, and education level were investigated using the chi-square test. Descriptive statistics such as frequencies, mean, median, standard deviations, , confidence intervals and percentiles were calculated.

### **3.7.1 Study I**

The comparison between participants with or without ABI was calculated using the non-parametric Mann Whitney U test for skewed data and t-test for normally distributed data.

The Area under the Receiver Operating Characteristic Curve (ROC) was used to analyse sensibility and specificity of the AWP measure based on the performance on the AdRT. This tool allows comparison of the performance of a set of different cut-off points or criteria for a screening or diagnostic test. The overall quality of a test is summarized by the Area under the ROC Curve (AUC), which ranges between 0 and 1. The larger the AUC, the more accurately the test predicts the disease in terms of specificity and sensitivity (115).

### **3.7.2 Study II**

The Friedman test (non-parametric alternative to the one-way ANOVA) was used for within-group and between-group analyses over the three measurement points. Mann Whitney U test was used for post-hoc analysis and for comparison between the intervention groups at each measurement point. Chi Square Tests were used to analyse nominal data over time.

### **3.7.3 Effect size**

To describe if the achieved treatment effects had a sufficient magnitude, the distributions of the test statistics were transformed into effect sizes (Cohens'd). According to Cohen (1988) (116), 0.2 is considered small effect, 0.5 medium effect and 0.8 large effect.

## **3.8 ETHICAL CONSIDERATIONS**

The study protocol was approved by the Regional Ethical Review Board in Stockholm, Sweden. Study II is registered at clinical trials. gov, trial registration: NCT02091453, 19 March 2014.

Participants received oral and written information according to the Declaration of Helsinki regarding their participation in the study, and they all gave written consent.

Participation in Study II was quite demanding as to length of training and intensity and therefore the participants were informed that they could decline the voluntary participation in case they experienced the training to exhausting.

## 4 RESULTS

### 4.1 STUDY I

#### 4.1.1 Content validity of the AdRT using AWC

The Structured Work Task application AdRT, evaluated with the work task analysis instrument AWC, was found to set frequent demands on abilities such as reading and following instructions, searching for information, maintain focus and monitoring and if necessary correct performance, and use of keyboard and computer in an appropriate way. The AdRT does not place frequent requirements on motor skills except fine motor skills and sets no demands on the ability to communicate or interact with other individuals. Table 5 presents the result of the AdRT being analysed with the AWC. The evaluation showed that especially the process skills Mental Energy, Temporal organization, Knowledge, and Adaptation, and the motor skill Coordination are always needed for competent performance of the AdRT.

#### 4.1.2 Revised AWP scoring

Data from the comparison group (CG) percentiles for performance time and errors) was used to establish reference values to support the AWP scoring. Performance within the first 25 percentile received score 4 ( $\leq 42$  min, 0-4 errors), performance between the 26-75 percentiles received score 3 or 2 (43-50 min, 5-9 errors) and performance above 75 percentile score 1 ( $>51$  min,  $>10$  errors).

The patient group (PG) showed significantly more deficits than the CG in several process skills. Compared with the CG, the PG had significantly less ability to search for, pay attention to, and remember task-relevant information. This resulted in significantly lower scores on the process skills Mental Energy and Knowledge ( $p < 0.001$ ). The PG also scored significantly lower on the process skill Temporal Organization due to difficulties in initiating and continuing performance without being distracted ( $p < 0.001$ ) and had more difficulties in noticing errors and change strategies for performance, resulting in lower scores on the process skill Adaption ( $p < 0.001$ ).

The PG showed significantly more deficits than the CG in all motor skills (Coordination and Physical Energy;  $p < 0.001$ , Posture;  $p < 0.019$  and Strength and Effort;  $p < 0.05$ ). Compared to the CG, the PG had significantly greater activity restrictions due to impaired fine motor movements, physical fatigue, reduced ability to coordinate body parts and maintain effective trunk control.

The AdRT mainly requires individual work at a computer. Due to this, the AWP communication and interaction skills were assessed as irrelevant or impossible to assess.

Table 5: Result of evaluation of the AdRT using the AWC. Level of skills needed to effective and efficient perform the AdRT. Rating levels: 1 = never needed, 2 = occasionally needed, 3= frequently needed, 4= always needed

AWC Skills		Rating level
<b>Motor skills</b>		
Posture	Ability to stabilize and position in relation to environment and task	3
Mobility	Ability to move the body and body parts in relation to the environment	2
Coordination	Ability to coordinate movements of body parts in relation to each other and the environment	4
Strength	Ability to use strength/handle objects in an appropriate manner	3
Physical Energy	Ability to perform/complete a work task within a reasonable time and without becoming physically exhausted	2
<b>Process skills</b>		
Mental Energy	Ability to perform and complete the work with preserved attention and without becoming fatigued	4
Knowledge	Ability to acquire, learn and use knowledge/tools and perform the work task according to aim and goal	4
Temporal Organization	Ability to initiate, continue, complete and perform task moments in a logical sequence	4
Organization of Space and Objects	Ability to organize work space and tools	2
Adaptation	Ability to note/react, adjust behavior and adapt environment as a reaction on performance cues	4
<b>Communication and Interaction Skills</b>		
Physicality	Ability to physically communicate and interact with other people	1
Language	Ability to use language for communication and interaction	1
Relations	Ability to provide communication and social fellowship with other persons	1
Information Exchange	Ability to exchange information with other	1

### 4.1.3 Specificity and sensitivity of the AWP using the Structured Work Task application AdRT

An analysis of the specificity and sensitivity resulted in a prediction AUC of 0.91 when using the AWP Process scale and 0.97 when using both the AWP Motor and Process scale. Thus, the AWP using the Structured Work Task application AdRT showed very high specificity and sensitivity to differentiate between the two participating groups. Based on performance on the work task, more than nine out of ten participants belonging to either PG or CG were placed in the correct group. The sensitivity for the AdRT was slightly higher than the specificity to correctly identify ABI patients (Figure 4).

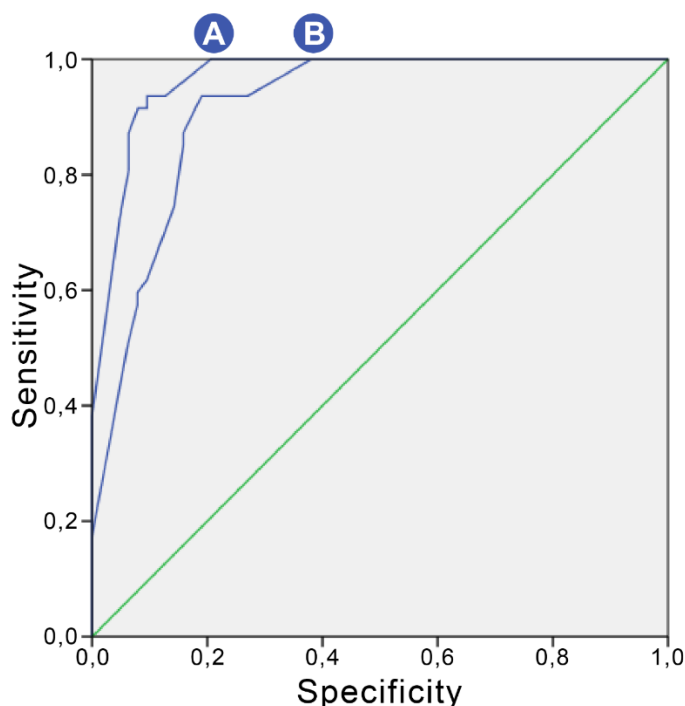


Figure 4: Specificity and sensitivity for the task application AdRT assessed with the AWP Motor and Process Skills

A: Specificity and sensitivity using the AWP Process and Motor Skills, B: Specificity and sensitivity using the AWP Process Skills

## 4.2 STUDY II

In study II the effects of two different cognitive rehabilitation approaches, APT and ABAT were compared. Since the emphasis was on remediation of attention impairment, attention-demanding activities were selected for the ABAT group. Outcome measures targeted activity and participation in daily life and work.

Patients receiving the APT intervention significantly improved within the process skills 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 ( $p=0.001$ ,  $ES=1.59$ ). APT patients also showed an advantage in the motor skill Physical Energy ( $p=0.003$ ,  $ES=1.21$ ). The ABAT group showed significant improvement in the motor skill Coordination ( $p=0.001$ ,  $ES=1.49$ ). Effect sizes were large. The improvement trajectories varied over time. See Figure 5 for graphs of the

four AWP process skills, where significant differences were found between the two intervention groups.

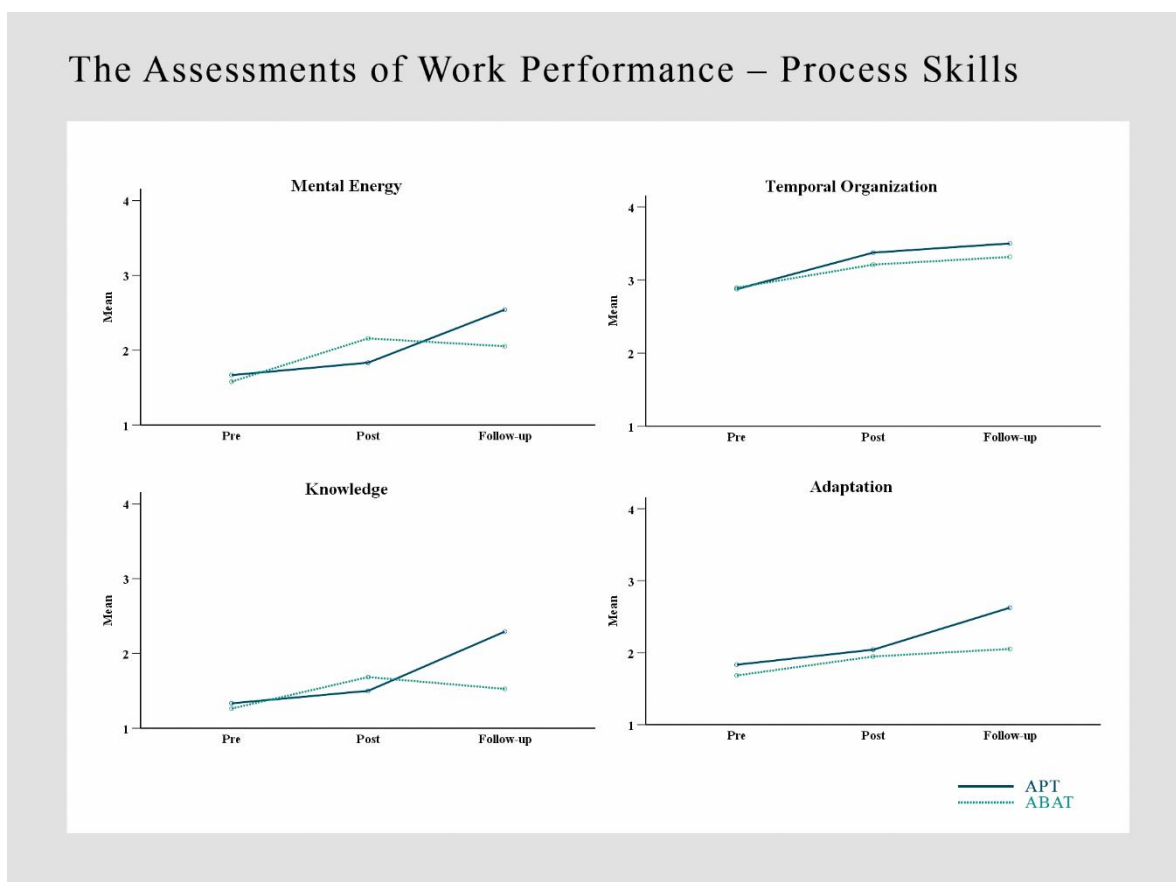


Figure 5: Graphs of the six AWP skills, where significant differences were found between the two intervention groups. The charts were based on the mean values for each group at pre, post- and follow-up assessments where y-axis values represent 1: deficient performance, 2: inefficient performance, 3: uncertain performance, and 4: competent performance

The results of the impact of attentional deficits as behavioural manifestations of daily activities (RSAB  $p=0.52$ ,  $ES=0.19$ ) and performance and satisfaction in daily occupations (COPM performance  $p=0.37$ ,  $ES=0.27$  and COPM satisfaction  $p=0.74$ ,  $ES=0.97$ ) showed no significant difference between the two intervention groups. The same was true for the self-assessed total work ability score (WAI  $p=0.70$ ,  $ES=0.14$ ).

In summary few differences occurred between the treatment groups despite the results from AWP using a structured cognitive demanding work task. However, a question raises. Had the patients improved, were they stationary or had their behaviour/performance deteriorated over time? To answer this question, within-group comparisons were performed.

The APT intervention group improved significantly over time in their work performance during a structured cognitively demanding work task in the motor skills Physical Energy ( $p=0.048$ ,  $ES=1.07$ ) and the process skills 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 the motor skills Physical Energy ( $p=0.042$ ,  $ES=1.41$ ) and Coordination ( $p=0.007$ ,  $ES=2.09$ ) and in the process skill Mental Energy ( $p=0.016$ ,  $ES=1.75$ ). The effect sizes were large.

There were significant improvements after the APT intervention on the WAI Total Score, Categories, and Individual Resources, and on the WAI subdimension a, d and g. For the ABAT intervention group, significant improvements were seen on Individual Resources and the specific dimensions a and  $b_2$  (Table 6). The changes occurred for some patients during the three months' interval between the completed treatment and the follow-up and in others gradually during the time between pre-assessment and follow-up.

*Table 6: Results for the APT and ABAT groups on the WAI, showing p-values and effect sizes over the three measurement points (pre-post-follow-up) for Total Score, Categories and for every sub-dimension separately*

		Pre-Post-Follow-up		Pre-Post	Post-Follow-up	Pre-Follow-up
		p-value <sup>c</sup>	effect-size <sup>d</sup>			
<b>WAI Total Score</b>	ABAT	0.077	1.44			
	APT	<b>0.003</b>	3.70	0.361	<b>0.022</b>	<b>0.001</b>
<b>Individual Resources<sup>a</sup></b>	ABAT	<b>0.015</b>	2.27	0.584	<b>0.008</b>	<b>0.041</b>
	APT	<b>0.004</b>	3.23	0.411	<b>0.006</b>	0.055
a. Current work ability compared with life-time best	ABAT	<b>0.030</b>	2.60	0.453	<b>0.024</b>	<b>0.003</b>
	APT	<b>0.007</b>	2.23	0.289	0.063	<b>0.004</b>
b <sub>1</sub> . Work-ability in relation to physical demands in current work	ABAT	0.328	0.99			
	APT	0.196	2.81			
b <sub>2</sub> . Work-ability concerning mental demands in current work	ABAT	<b>0.030</b>	1.53	0.465	0.224	0.052
	APT	0.178	0.94			
f. Expected work-ability in the forthcoming two years	ABAT	0.814	0.31			
	APT	0.939	0.02			
g. Enjoy your regular daily activities (mental resources)	ABAT	0.575	0.51			
	APT	<b>0.020</b>	2.09	0.121	0.648	<b>0.045</b>
<b>WAI Individual Health Factor<sup>b</sup></b>	ABAT	0.946	0.02			
	APT	0.059	1.48			
c. Total number of medical diagnoses	ABAT	0.651	0.43			
	APT	0.368	0.76			
d. Estimation of work impairment due to diseases	ABAT	0.164	0.49			
	APT	<b>0.025</b>	1.85	0.093	0.724	<b>0.042</b>
e. Sickness absence during the last year	ABAT	0.878	0.25			
	APT	0.549	0.57			
<b>WAI Categories</b>	ABAT	0.072	1.47			
	APT	<b>0.002</b>	4.08	0.121	0.548	<b>0.045</b>

<sup>a</sup>: Total score for the WAI dimensions a,b<sub>1</sub>,b<sub>2</sub>,f,g, <sup>b</sup>: Total score for the WAI dimensions c,d,e, <sup>c</sup>: Friedmans Test, <sup>d</sup>: Cohen's d, <sup>e</sup>: Wilcoxon Signed Rank Test, Exact sig. (2-tailed).

Significant within-group improvement was found between pre-and post-assessment for both intervention groups on the COPM performance and satisfaction scales as well as for the impact on attentional deficits in everyday activities (RSAB). The effect size showed large effects on these measures (Table 7).

*Table 7: Pre-post-assessment for the APT and ABAT groups on the COPM Performance and Satisfaction and for the RSAB Total Score, showing p-values and effect sizes*

Assessment	APT		ABAT	
	p-value <sup>a</sup>	effect-size <sup>b</sup>	p-value <sup>a</sup>	effect-size <sup>b</sup>
<b>COPM Performance</b>	<b>0.001</b>	1.85	<b>0.001</b>	1.84
<b>COPM Satisfaction</b>	<b>0.000</b>	1.92	<b>0.000</b>	2.40
<b>RSAB Total Score</b>	<b>0.027</b>	1.03	<b>0.007</b>	0.81

<sup>a</sup>: Wilcoxon Signed Rank Test, Exact sig. (2-tailed), <sup>b</sup>: Cohen's d

In summary, the within-group comparisons showed that work performance using the AWP and a structured cognitively demanding work task, self-assessed work ability, and performance and satisfaction in daily occupations, had improved for both the APT and the ABAT groups. These measures showed intermediate to strong effect sizes.

## 5 DISCUSSION

In this thesis, the focus was on evaluating attention training in the sub-acute phase after ABI on occupational performance using different assessment methods on level of activity and participation. Two studies were included, one methodological describing the development of an attention-demanding task, the AdRT, that was used as a task application to the AWP, and one RCT study, evaluating the effect of attention training in the sub-acute phase after ABI on daily activity, work performance and perceived work ability.

The choice of measurement instruments was an essential point in designing the studies, particularly for the assessment of work performance, since an initial survey showed that no suitable, structured, standardized work task was to be found in the literature. The AWP task application AdRT was found to be sensitive in detecting attention deficits and set frequent demands on process skills for accurate performance. Therefore, the task was considered a suitable task application for assessing work performance with AWP in the following RCT study. The occupational perspective emphasizes the importance of the performance of an individual in his/her everyday environment and work situation. However, a recent review found that the measurement properties of performance-based instruments for cognitive skills after brain injury is very limited (117).

As normal performance of a work task in terms of goals, quality and performance speed need to be defined to objectively measure the quality of performance (48), data from healthy individuals was collected as reference values of normal performance of the AdRT. To reduce impact of rating inconsistency (46, 47, 118-121) a scoring guidance was also developed, linking observed performance difficulties and the reference data of normal performance of working individuals, to the assessment levels of the AWP. Using this AWP scoring guidance, AdRT was found both sensitive for the presence of attention deficits (methodological study) and able to capture individual changes as measured with the AWP process skills (RCT study). The use of the structured scoring method may have helped in reducing potential rating bias when using performance-based assessments (such as applying scoring scales in an inconsistent manner (46) and knowledge changes resulting in rating differences over time (47).

Today, the concept of combining specific standardized work situations/work tasks with the AWP for the assessment of work ability is an accepted method within the Swedish Social Insurance Administration (122).

Attention training using the APT and ABAT resulted both in significant improvements on COPM and RSAB immediately after completed intervention. Due to clinical reasons these measures were not followed at the three months follow up assessment. However, three-month post-intervention participants who received APT performed significantly better than ABAT on several AWP process skills. This highlights the importance of not only evaluating the effect of an intervention immediately after completion but also evaluating its efficiency over

time. However, several meta-analyses show that the most common design is pre- and post-measurements (123-127).

In the present RCT study the participants continued their sick-leave or returned to some degree of work between the post- and follow-up assessment. The participants receiving APT showed improved work task performance three-month post-intervention, both compared to the ABAT group and compared to their own task performance immediately after completed rehabilitation. One reason for this improvement may be due to the transfer of skills and knowledge to activities outside the clinical setting. Markovic (128) found that patients receiving APT in early phase after ABI, 2-4 years thereafter still engaged in continuous self-training and refined goal setting through self-evaluation.

Within occupational therapy there is an ongoing discussion if occupational therapy interventions should target the body function or the activity and participation areas (129). The APT approach includes the main components for the remediation of attention deficits through repetitive tasks with increased difficulty, and facilitation of transfer of gains from the treatment setting to everyday activities (80). Similar elements are found in other functional intervention protocols such as constraint-induced therapy (CI therapy) proven effective in reducing both motor and speech deficits (130). The CI therapy approach relies on four components: intensive function training, training by shaping, generalization of training gains to daily activities, and discouragement of compensatory strategies. Both APT and CI therapy highlight the importance of transferring treatment gains to activities of daily living through techniques making the patient more active in their own training outside the treatment setting (80, 130).

Studies concerning the effects of cognitive training on occupational performance are limited and often self-estimating assessments and/or standardized neuropsychological instruments are used as evaluation tools (31, 33, 131). Therefore, a need for more RCTs using occupational performance as the primary outcome measure has been required (132). Research indicates that the evaluation of occupational performance with performance-based instruments is a more valid and accurate approach to assess abilities in daily life and work ability (32-35). Therefore, in the present thesis the use of self-assessments was combined with performance-based instruments i.e. assessment of actual task performance. The purpose of performance-based assessments are to identify the individuals present physical and cognitive abilities or limitations in relation to actual task demands (41). To the authors' knowledge only three studies (133-135) have measured the effect of attention training using performance-based assessments. Two of them, Björkdahl (134) and Couillet (135) found a positive effect on performance, an effect that was maintained at three-month follow up. In the third study (133) the number of training sessions (9 hours) was insufficient to achieve a measurable positive effect, as later studies in our group showed, that more training sessions are required (136).

Attention deficit after ABI have been found to be one of the cognitive functions that may be successfully improved through systematic training with APT (27, 76, 124). Effects have been seen at the impairment level (attention, memory and executive functions) (80, 81, 133) and at

the activity level when using self-assessments or interviews (80, 81). To the authors knowledge effectiveness of attention training on actual work performance or work ability has not yet been investigated. One reason may be methodological as it until recently has been a lack of standardized assessment methods of actual work performance (33).

There were some limitations in the studies. In the present RCT the number of potential participants was significantly reduced due to the strict selection criteria recommended for strengthening the generalizability of RCT results (CONSORT). Thus, the results reflect the performance of a relatively homogeneous group of patients within one year after ABI, with mild to moderate symptoms and without symptoms interfering with testing (aphasia, motor or visual impairment) (1) or conditions interfering with interpretation (e.g. premorbid problems of attention) within 18-60 years of age. Thus, further studies are needed to examine the effects of attention training on daily performance in children and in elderly persons after ABI. Another limitation might be the selection of the control group, a convenience sample, in Study 1.

We found in the present study that at the three months follow-up, the APT may be more effective than ABAT in treating attention deficits in the sub-acute phase after ABI. However, as the intervention trial was carried out as a part of the standard interdisciplinary rehabilitation program, all patients received interventions individually or in a group by other professions (such as speech therapist, PTs, psychologists, nurses', physicians, and social worker) at the same time as they received APT or ABAT which may have influenced the results. Since the patients were randomized this influence may be distributed equally for the two intervention groups.

## **6 CONCLUSIONS**

The Structured Work Task application, the AdRT, assessed with the AWP, proved to be sensitive to attention deficits. Therefore, the AdRT was considered suitable and used as assessment task for evaluation of treatment effects of attention training on actual work performance after ABI. Using the AdRT together with the AWP enabled comparison of treatment effects.

Both traditional occupational therapies focusing on attention impairment, and APT are beneficial for improving occupational performance but APT compared to traditional occupational therapy, contributes to additional improvement of process skills. APT may improve work performance and work ability, in attention demanding work-tasks.

APT in combination with metacognitive training should be considered as a part of the intervention for patients with attention impairment, receiving rehabilitation by OTs.

## 7 SVENSK SAMMANFATTNING

Efter en förvärvad hjärnskada är det vanligt med kvarvarande kognitiva nedsättningar såsom nedsatt uppmärksamhet, minne och rumslig förmåga. Vid nedsatt uppmärksamhet är det vanligt att individen upplever nedsatt mental uthållighet, distraherbarhet och nedsatt simultankapacitet i vardagen.

Kognitiv rehabilitering syftar till att med hjälp av återtränande och kompensatoriska åtgärder öka individens kognitiva funktionsförmåga i vardagen. Återtränande interventioner syftar till att förbättra den påverkade funktionen genom intensiv, repetitiv funktionsträning med generaliseringsträning i vardagen. Kompensatoriska interventioner fokuserar på att förbättra aktivitetsförmågan genom att kompensera för förlorad funktion.

Huvudsyftet med föreliggande studie var att utvärdera effekten av två olika former av uppmärksamhetsträning, Attention Process Training (APT) och Aktivitetsbaserad uppmärksamhetsträning (ABAT) på aktivitetsförmåga och upplevd arbetsförmåga i det subakuta (4–12 månader) skedet efter stroke eller traumatisk hjärnskada. Utvärdering skedde på aktivitets- och delaktighetsnivå med instrumenten AWP, COPM, RSAB och WAI vid tre mättillfällen; inom två veckor före påbörjad träning, upp till två veckor efter avslutad träning och tre månader efter genomförd eftertestning.

För att utvärdera effekten av uppmärksamhetsträning på faktiskt aktivitetsutförande behövdes en aktivitet som dels var kognitivt krävande för korrekt utförande, dels var möjlig att använda vid upprepade testtillfällen. Eftersom någon sådan aktivitet inte återfanns vid en litteraturgenomgång beskriver den första studien i denna avhandling utvecklandet av en uppmärksamhetskrävande utvärderingsaktivitet (AdRT) att använda tillsammans med bedömningsinstrumentet AWP vid kommande interventionsstudie. Referensvärden för normalt utförande samlades in av 47 arbetsföra individer och länkades till AWP:s skattningsnivåer. Därefter jämfördes den arbetsföra gruppens utförande med prestationen hos 65 patienter med fastställt nedsatt uppmärksamhetsförmåga till följd av förvärvad hjärnskada. Analysen visade att AdRT hade god förmåga att diskriminera mellan individer med och utan förekomst av uppmärksamhetsnedsättning.

Den andra delen av denna avhandling beskriver genomförandet av en randomiserad kontrollerad studie vid en större rehabiliteringsklinik. 51 patienter med förvärvad hjärnskada erhöll tjugo timmar uppmärksamhetsträning med antingen APT eller ABAT. APT är ett träningsprogram med god evidens avseende effekt på funktionsnivå och självupplevd förbättring i vardagen men där effekten är mindre utforskad på faktiskt aktivitetsutförande. Aktivitetsbaserad uppmärksamhetsträning fokuserar på träning i kognitivt krävande aktiviteter och användning av strategier för optimerat aktivitetsutförande. Träning i kognitivt krävande aktiviteter har tidigare visat effekt både på kognitiv funktion och utförande i aktiviteter i vardagen.

Ingen skillnad i behandlingseffekt sågs mellan APT och ABAT på instrumenten WAI, RSAB och COPM; båda grupperna uppvisade likvärdig förbättring på dessa utvärderingsmått.

Gruppen som erhöill APT presterade däremot bättre än ABAT gruppen på flertalet AWP processfärdigheter, en skillnad som var mest framträdande vid den uppföljande testningen tre månader efter avslutad behandling. APT gruppen skattade vid denna testning även sin arbetsförmåga som förbättrad jämfört med tre månader tidigare, en förbättring som inte sågs i gruppen som erhöill ABAT.

Sammanfattningsvis visade sig AdRT känslig för förekomst av nedsatt uppmärksamhet och visade sig även ha förmåga att fånga förändrad funktionsförmåga över tid. Inom ramen för ett interdisciplinärt rehabiliteringsprogram förefaller träning med APT vara en mer effektiv metod än ABAT i att förbättra utförande i kognitivt krävande aktiviteter. Denna studie visar att det är möjligt att utvärdera effekt av kognitiv träning på aktivitetsnivå om använd utvärderingsaktivitet är känslig för förändrad förmåga i den funktion som tränats. Studien visar också på vikten av att utvärdering inte bara sker direkt efter avslutad intervention utan även på länge sikt för att se om uppnädd effekt kvarstår.

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