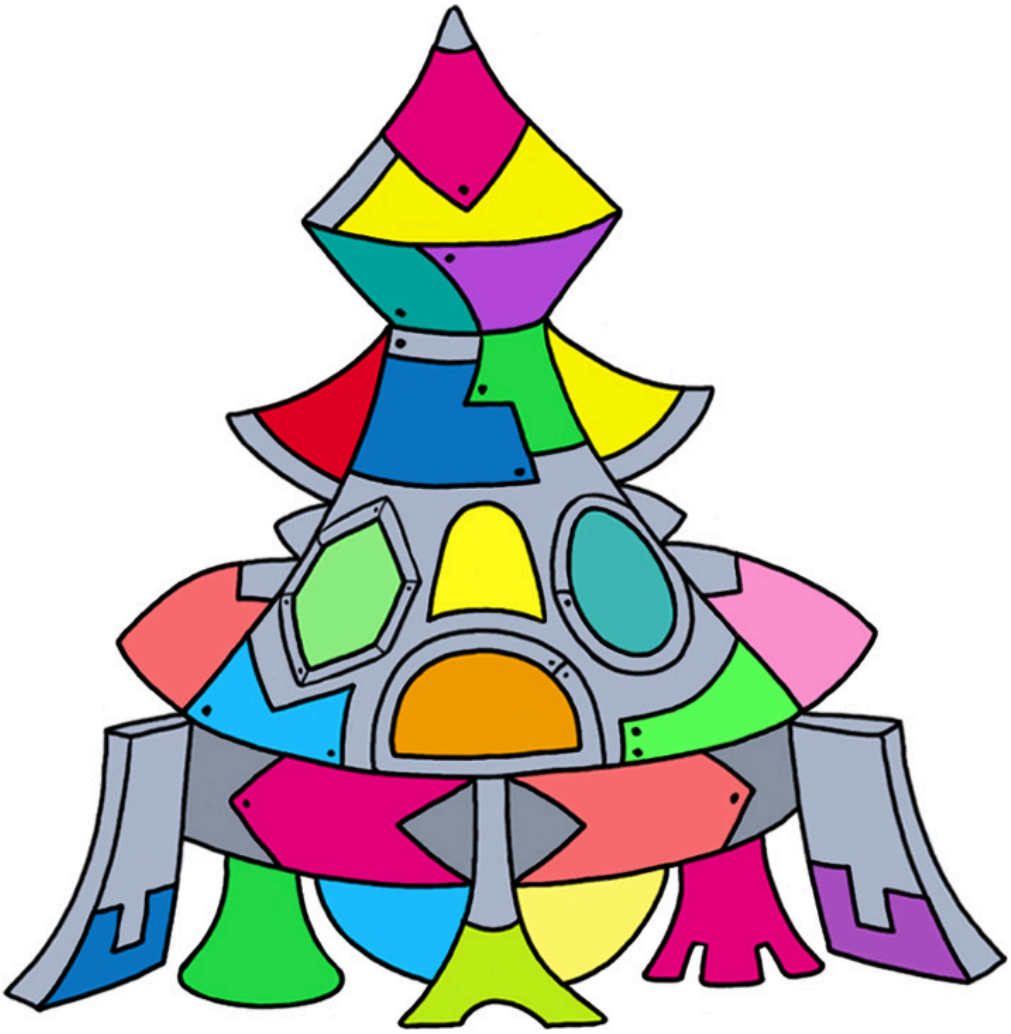
Working Memory Training
-theory and practice



Erik Truedsson, clinical psychologist
Stefan Strohmayer, clinical psychologist

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PREFACE

Working memory training has become a common practice in many schools and homes during the last few years. Since 2006 we have been given the opportunity to present a long series of lectures, conferences and training courses for, among others, teachers, psychiatrists, psychologists, special education teachers and parents of children with concentration difficulties.

The interest in working memory training seems to continue to grow, while at the same time, more and more research is being carried out in the field. In recent years it has been demonstrated that working memory training can have a positive impact on a number of areas. Some examples include improved concentration ability, impulse control and arithmetic skills in children with ADHD, increased working memory capacity in children with poor working memory and strengthened problem solving ability in adults. Much research remains to be done and within a few years, hopefully more will be known on the benefits of working memory training.

This book is intended for those who have an interest in working memory training. It can be used as a complement to the computer software Memory Quest for those who are going to coach a child or an adult or if you are about to train on your own. Furthermore, this book also serves as an independent source of information on working memory and working memory training.

The book consists of two main parts. In the first part we describe the memory system in general and then give a more detailed description of working memory. Among other things, we describe how working memory capacity can be measured, how it is connected to school achievement and cognitive functions, and how working memory can be trained. We then describe two target groups who can benefit from working memory training: children and adults with ADHD as well as those with poor working memory. Finally, we give an overview of research and evaluations made on working memory training.

The second part of the book is primarily aimed at those who are going to coach a child or an adult who is going to train their working memory. This section provides information about things to consider before training, during training, and after training. It includes practical tips and materials that can be used in connection with the training. It also gives our thoughts on how motivation can be maintained during the whole training period and what is important to consider when evaluating the training. Finally, we present case descriptions to demonstrate how working memory training can be conducted in practice.

Stockholm, 12th of August 2010

Stefan Strohmayer & Erik Truedsson

THEORY

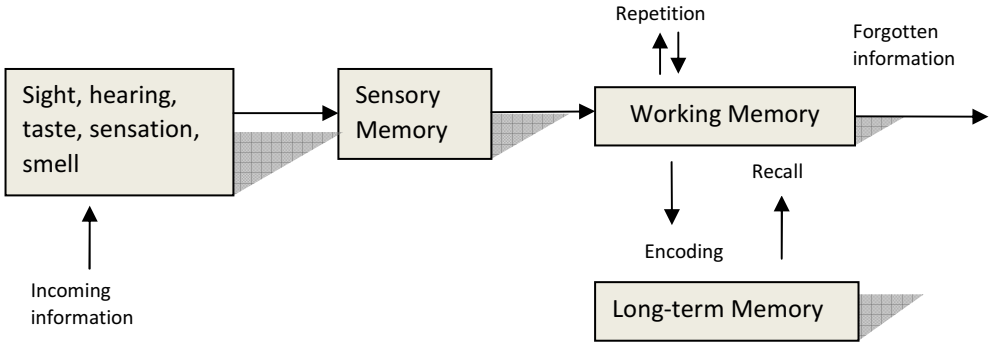
INTRODUCTION

From birth and throughout life, we are constantly dependent of our memory. In almost all human activity a memory function is involved: when we read the newspaper in the morning, when we drive our car to work, when we solve a task together with our colleagues, or when we watch TV in the evening. Without functioning memory, many everyday activities become overwhelming.

MEMORY

In our daily lives, we are constantly exposed to information that is first processed by our sensory systems, such as hearing and sight. A small part of the information we receive falls into our consciousness and is managed by our working memory. Of the information that we process in our working memory only a fraction will, in turn, be stored in our long-term memory as a result of deeper processing.

FIGURE 1: MEMORY - FROM INCOMING INFORMATION TO ENCODING



SENSORY MEMORY

In our sensory memory we store incoming information from our senses for a very short time. All new information will first pass through our sensory memory before it is transferred to other parts of our memory system. The sensory memory consists of different types of sensory registers that handle information from our various senses such as hearing, sight and touch.

WORKING MEMORY

We need working memory to maintain, process and use information in "real time". It is also a necessary component in order for us to learn new skills. A characteristic feature of working memory is that its capacity is limited. Working memory will be described in more detail later in the book**.**

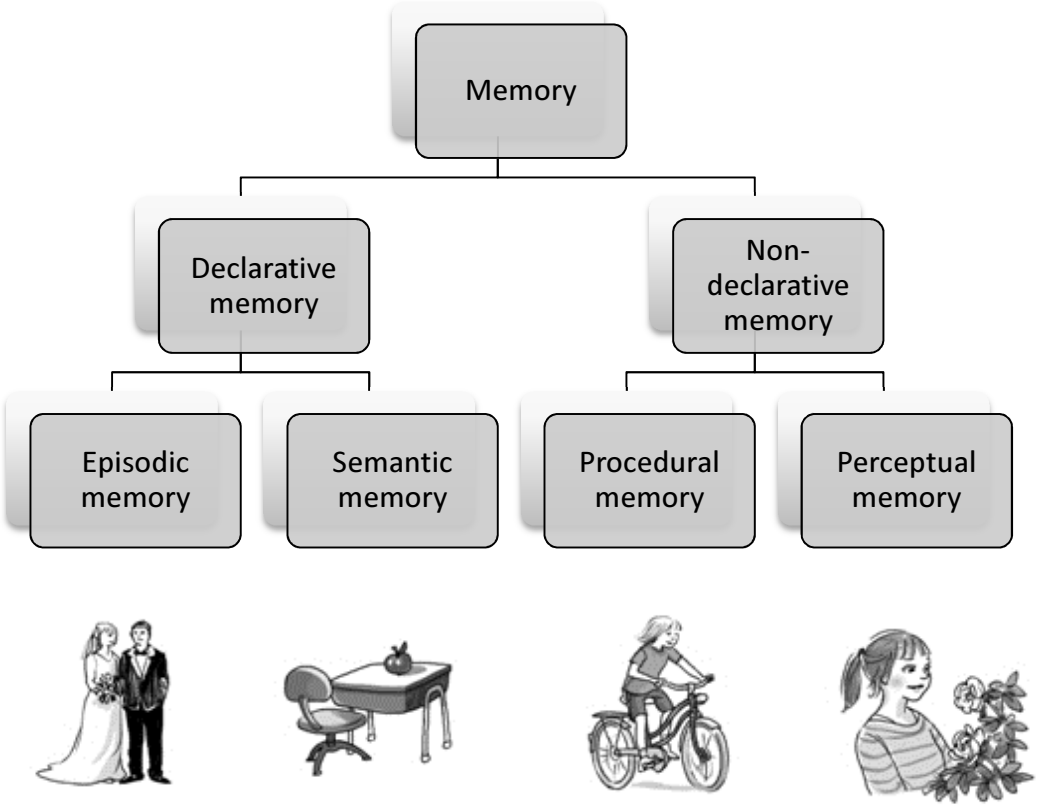
LONG-TERM MEMORY

Our long-term memory can store a very large amount of information over a long period of time, sometimes for life. A common view is that information passes through working memory before storage in long term memory.

Long-term memory is usually divided into two sub-categories: declarative memory and non-declarative memory. Declarative memory is primarily information that we can put into words and can in turn also be divided into two types: semantic memory and episodic memory. In the semantic memory we store general knowledge, for example names of capital cities, as well as information about the meaning of various words; it is therefore closely related to learning. In the episodic memory we store information about our personal experiences and it often answers the questions where, when, and how? For example: Where was my vacation last year? When did my cousin get married? How did we celebrate my eighteenth birthday?

Non-declarative memory involves experiences we intuitively find difficult to put into words and can be divided into two types: procedural memory and perceptual memory. Procedural memory is the memory of how we carry out various practical activities. Knowledge about how we ride a bike or drive a car are examples of information stored in procedural memory. Perceptual memory is our memory for different types of sensory experiences for example how a strawberry tastes or how corduroy feels to touch.

FIGURE 2: AN OVERVIEW OF THE MEMORY SYSTEM



The term working memory was first introduced in the 1960s. Before that the term short-term memory that was used instead, which is our capacity to keep information in memory over a short period of time. With the term working memory the description of this memory system changed from being only a passive maintenance of information to also include active processing and manipulation of information. Working memory concerns our ability to hold, process and use information in real time.

This capacity is extremely limited, which, among others, the American researcher George Miller noticed. In his experiments in the 1950s he saw that there was a clear limit to the number of objects that test persons generally managed to repeat when he presented word sequences to them. More recent research has also shown that there is a large variation in working memory capacity between individuals, and that this variation often is an important factor for understanding the differences in intelligence, problem solving ability and reading comprehension between individuals.

We use our working memory on a daily basis in a variety of situations. Even before you leave home to go to work in the morning, you use your working memory. An example is when you pack your bag for a holiday. This involves working memory to a high degree because you need to keep in mind what you will be doing during the holiday and what you need for the different activities. To what extent you bring with you the right things for your holiday therefore depends largely on your working memory capacity. If your working memory is overloaded there is a great risk that you might forget important things. To reduce the load on working memory you can use strategies such as the one described below.

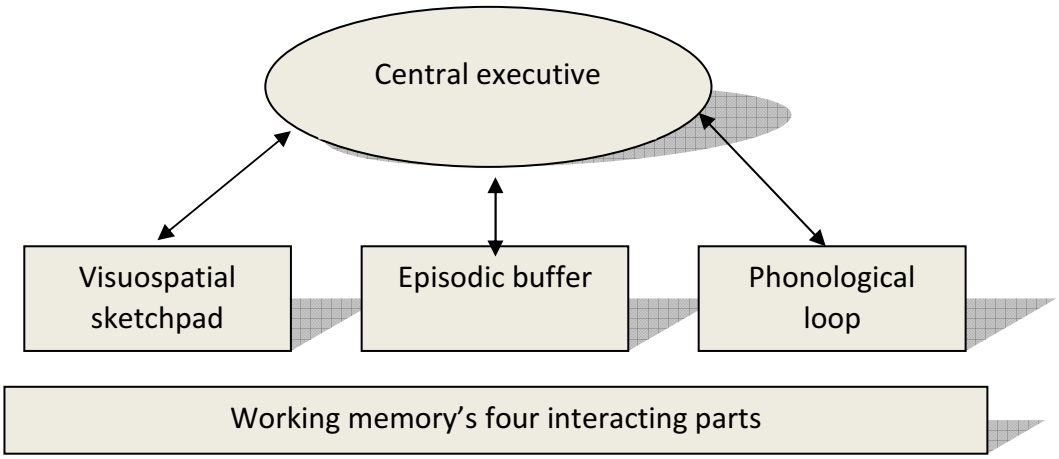
Suggestion!

An example of how you, in such situations, can help your working memory is to use a paper and pen. This way you can hold a part of the information outside yourself so that you do not need to have everything in your head. This is particularly appropriate for days when you are stressed or have slept too little, because these are factors that we know affect our working memory ability negatively.

Working memory has been studied from a variety of perspectives such as biological (cells, genes), psychological (cognitive development) and pedagogical (behaviour in the classroom). As a result there are definitions of what working memory is, and the focus and content of these descriptions often reflect the specific fields from which they have evolved. However, a common denominator for most definitions of working memory is that it is viewed as a temporary system to maintain and manipulate information and that it has a limited capacity.

The researchers Alan Baddeley and Graham Hitch presented a model for working memory that is still the most commonly used. In this book, we will use Baddeley's model to describe working memory in more detail. Baddeley's model of working memory is called the multi component model because it is composed of multiple processes (components) that interact with each other. The current model consists of four parts: the phonological loop, the visuospatial sketchpad, the episodic buffer and the central executive (see Figure 3). Studies over the past three decades have provided empirical support for the components of working memory in Baddeley's model.

FIGURE 3: BADDELEY'S MODEL OF WORKING MEMORY



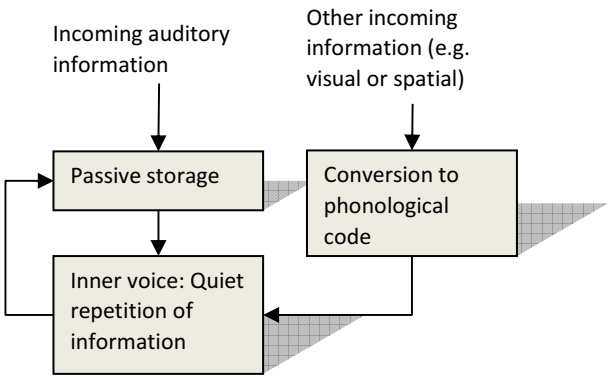
THE PHONOLOGICAL LOOP

The phonological loop manages auditory information. Here we handle not just information that we collect with hearing, but also impressions that we take in via other senses and convert to phonological code. The phonological loop consists of two parts. Firstly, a passive storage where the information will be held only a few seconds and then disappear. Information that has been lost from the passive storage, or the inner ear that it is also sometimes called, cannot be retrieved. In order to retain information submitted to the inner ear over a longer period of time, it is necessary that the phonological loop's second part, the articulatory system, is activated.

The articulatory system serves several purposes. It uses an inner voice to retrieve information from the passive storage, repeats it quietly and then returns it to the passive storage in order to be able to retain the information over a longer period of time. This, thus, becomes a loop that retrieves the auditory information and then returns it. This function is called the articulatory loop (see Figure 4).

The articulatory system also converts visual impressions to phonological code by using the inner voice to give names to the visual impressions. An example of this is that when we are shown a digit code on a piece of paper that we must remember we often (automatically) choose to repeat the digits "quietly in our head" to remember them better.

FIGURE 4: THE ARTICULATORY SYSTEM



There is support from several studies that the phonological loop provides an accurate description of how memory actually works when we handle auditory information. It has been shown that it is easier to remember words which sound different than words that sound similar. If we try to recall a series of words that sound similar, the likelihood that we will remember wrong significantly increases, because we are more likely to mix up similar words. It is therefore more difficult to remember the series "blue, canoe, clue, shampoo, shoe" than the series "cat, yellow, kangaroo, house, soap". This is called the phonological similarity effect.

It has also been shown that it is more difficult to remember sequences of words with many syllables than series of monosyllabic words; it is therefore more difficult to remember the series “catamaran, rhinoceros, crocodile, lighthouse, telescope" than the series "dog, boat, salt, bat, screen". This is called the word-length effect. This effect is believed to be due to the fact that it takes longer for us to repeat long words and that we lose information along the way before we manage to repeat all words in a sequence of words with many syllables. This means that the number of items you can remember on verbal working memory tests is dependent of what language you speak. For example, it has been shown that Welsh children can repeat fewer digits than English-speaking children because lists of digits take longer to articulate in Welsh.

The amount of information we can keep in the phonological loop is also connected to our speech rate; that is, individuals with a strong verbal working memory often have a higher speech rate (measured in words/second) than individuals with weak verbal working memory. This depends on the fact that the speed of our spoken voice is approximately the same as for our “inner voice" (which we use to maintain information).

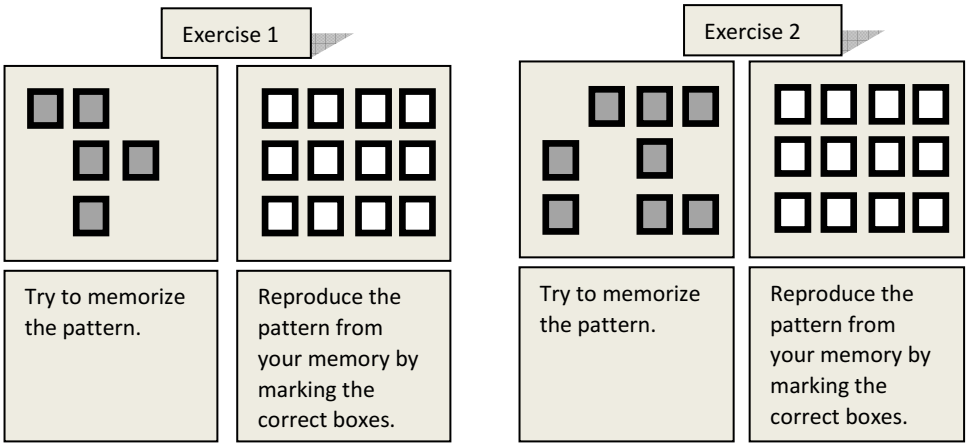
An example of when the phonological loop is used is when you are trying to remember an entry code that someone has told you. Imagine that you are in town and bump into a friend. You decide to meet at his friend’s home for a snack an hour later. You have forgotten your mobile and neither you nor your friend has pen or paper. You are on the way to work, one block away, where you have access to pen and paper. Your friend says her entry code to you: "18 24" and you part ways. To remember the entry code while you walk to work you will repeat the digits in your head with your inner voice. When you then arrive at work, you have succeeded in retaining the information in your memory and can write it down.

THE VISUOSPATIAL SKETCHPAD

The visuospatial sketchpad handles visual and spatial information. Just like in the phonological loop different types of impressions are processed in the sketchpad, but here they are transformed into visual impressions or spatial code. The visuospatial sketchpad is also necessary for our ability to create and manipulate mental images. The sketchpad can be divided into two parts: a visual part that takes care of information about objects shapes and colours and a spatial part that manages information about movement and direction.

To measure visuospatial working memory, tests in which visual sequences are to be encoded are often used. An example of this is to present block patterns that become more and more complex and within which positions for more and more blocks are to be memorized (see Figure 5).

FIGURE 5: EXAMPLE OF BLOCK PATTERN



An example of when you use the visuospatial system is when you need to remember directions of how to get somewhere. Imagine that you are out walking in town when a friend calls. She wants to meet you in the new shopping mall. You do not know where it is but she describes it for you. She knows where you are now and explains exactly which way you go in order to get to the mall.

She says – “first you go straight forward. At the convenience store turn left. Then you go past a toy shop and turn right. When you turn the corner you will see the shopping mall.” In order to remember how you will find your way you must maintain the description in your head. You must remember which places you will pass (convenience store, toy shop). Moreover, you must remember in which direction you must go at the different places (straight, left, right).

Another example of when the visuospatial system will be used is when you visualize in your mind how the pieces on a chess board would probably be moved over a number of moves ahead as a result of your intended next move.

THE EPISODIC BUFFER

The episodic buffer is the latest addition to Baddeley's working memory model. It was added after research revealed that information from long-term memory can have a profound effect on our working memory capacity. The episodic buffer is a temporary storage, where information from the incoming impressions, the phonological loop and the visuospatial sketch pad are integrated with information from long-term memory. The episodic buffer is considered important for learning because it can use multimodal code to integrate information from different systems into a single representation. Like the other components of working memory, there is a limitation in the amount of information that can be handled simultaneously.

An example of when you use the episodic buffer is when you solve a mathematical problem. In order to calculate five times seven you use the information presented to you, but you must also use information from long-term memory, (the rules for multiplication) in order to calculate the answer.

THE CENTRAL EXECUTIVE

The central executive, or the executive system as it is also called, coordinates and monitors the other systems in working memory. In addition, several aspects of how we use our attention are guided by the executive system. Firstly, the executive system determines our ability to focus attention and our ability to close out impressions that compete for our attention. When you sit at home and watch your favourite programmes you direct your attention to the television screen in front of you. At the same time, you close

out the impressions of your surroundings such as children playing in the next room or a bird chirping outside the window. This puts the executive system to work.

The executive system also controls our ability to divide attention between several tasks simultaneously. An example of when high demands are put on the executive system is if you correct a test while at the same time listening to the news. The executive system is activated even when an automatic mental process is disturbed or fails.

In order for us to make sense of larger amounts of information it is essential that part of the information can be handled automatically, i.e. without conscious mental effort. This is because the executive system must be able to devote resources to higher mental processes such as problem solving and reasoning. For example, if you are an adult, reading is an automatic process which means that while you read there are mental resources left to reflect on the meaning of what you have read. In contrast for a child, reading may be such a mentally-demanding activity that hardly any capacity is left to interpret and take meaning from the text.

The executive system is the part of working memory upon which there has been the least research. From currently available research it seems the executive system serves the functions mentioned above. However, it is probable that there are additional purposes not yet described.

DEVELOPMENT OF WORKING MEMORY

Working memory develops mostly between the ages of 5 and 11 years. A four-year-old has a relatively undeveloped working memory and can repeat an average of about three digits that have been read aloud. A twelve-year-old can reproduce on average about six digits, i.e. twice as many. Until about 15 years of age somewhat smaller but still significant improvements in working memory occur. A fifteen-year-old approaches an adult´s working memory capacity and can remember on average about seven digits. The increase in working memory capacity during childhood is believed to derive from improved basic skills such as processing speed and controlled attention, in addition to increased use of strategies such as repetition and Chunking (see section on next page).

Working memory capacity reaches its peak when we are around 26 years of age after which it slowly starts to diminish. However, it is only approximately around the age of 60 that working memory capacity is significantly impaired. There are a number of theories about how it is that working memory deteriorates with age. A partial explanation that has been identified is that the elderly appear to have more difficulties with preventing irrelevant information from long-term memory that is activated when working memory is used to solve a challenging task. For the vast majority the decrease in working memory capacity that age entails is not a major concern; with help from various strategies learnt during our lives, our memory is still, in most cases, sufficient. Deficiencies in working memory capacity can, however, be a more salient barrier with change of environment because information from long-term memory cannot be used for support to the same extent in new environments.

VARIATION IN WORKING MEMORY CAPACITY

An important aspect of working memory is the large variation in ability that exists between individuals, both in childhood and adulthood. In a class consisting of seven-year-olds differences in working memory capacity equivalent to as much as six years in development can be expected. In a class of seven-year-olds, therefore, some have a capacity equivalent to or even lower than the average four year old, while others have a working memory

capacity corresponding to the average ten year old. In a class of 30 students it can be expected that approximately three will be in the lowest range and about three in the highest.

CHUNKING

As early as 1956 the American psychologist George Miller suggested that the number of items that we can memorize is about seven. He also introduced a very important phenomenon, namely Chunking. Miller said that when we have to memorize something, we try to encode the information in as few units as possible. We try to group the information into larger chunks. As the number of chunks we can remember is limited, we try to gather as much information as possible in each chunk to maximize the amount of information we can remember. An illustration of chunking is that it has been shown that we are able to remember more words if they are taken from a literary text than if we try to memorize unrelated words, which probably is explained by the ability to connect the literary text into meaningful units. How many chunks we can actually remember is still much debated, but today it is often claimed that it is closer to four rather than seven.

The number of units we can store is consequently also an effect of how meaningful the pieces of information are when put together. For example, we can usually memorize about six words that do not relate to each other such as "hat, apple, guitar, lion, cheese, book", but can remember many more words if they form a meaningful sentence such as, "in Sweden there are many beautiful churches built in the Middle Ages ". This sentence can probably be reproduced by most people but to remember 11 words without any connection to each other after having read them once is almost impossible. This is an example of the above-mentioned effect, that we find it easier to memorize literary texts with connections between the words than to memorize unrelated words.

What constitutes a chunk depends on how we can manipulate and connect the information presented. For example, the numbers "1 9 7 1" can for a child be four separate units, but as an adult if you can group the numbers to form a meaningful unit (the year 1971) - it's actually rather just one chunk.

For a child who is just learning to read a long word can be a demanding working memory task. "B-e-g-i-n-n-e-r" can be 9 chunks. For an adult who has already learned to read, the grouping occurs automatically and when reading a long word the information is chunked into much fewer units than the letters of the word.

There is still no definitive research that shows the maximum amount of information our working memory can handle. There are many factors that determine working memory capacity, such as: processing speed, the amount of information we can process at a time, how fast information is lost, the volume of our temporary storage and our ability to close out distractors, etc. However, scientists have discovered that there is a general area of the brain that is activated when a series of working memory tasks are executed, which possibly determines our capacity for information of both spatial and auditory nature.

LOST INFORMATION

If information is lost from working memory it is gone and you have to start again. For example, if a friend says his phone number and you forget the digits, there is no way to access the information other than to ask your friend again. This differs from other information we may forget, for example, where we have placed our keys. In such cases, we can use our long-term memory and then mentally think through what we have done during the day to remember where we may have placed them.

WE CAN USE OUR LONG TERM MEMORY TO REMEMBER WHERE WE HAVE LEFT OUR KEYS

LEARNING AND ACADEMIC PERFORMANCE

Working memory has, in several studies, proven to be central to learning. Working memory is needed to deal with unknown and new problems and situations, to block out irrelevant information, and to consciously retrieve information from long-term memory. Furthermore, working memory is crucial to learning new skills that will eventually be automated, such as reading and writing. There is a strong link between working memory and children's achievement in reading, writing and mathematics; it may in many cases be advantageous to make an early identification of a child who has working memory deficits in order to facilitate learning.

Low capacity leads to frequent overload of working memory. When working memory is overloaded the task presented is not possible to solve because access to all the steps needed is not available. If this happens frequently, the risk is that it becomes an experience of a total inability. When a working memory task is not completed no new information will be stored in long-term memory, which means that no new knowledge will become available. This is therefore a form of learning disability which also becomes a negative spiral that grows over time as there is no natural construction of a knowledge bank to retrieve information from. This becomes an obstacle in the effort to get more confident in dealing with specific problems. Learning in general can suffer when the frequency of learning opportunities is limited.

To be able to read and comprehend a text puts high demands on our memory. We must firstly recognize letters and their phonemes. Secondly we must put them together according to the rules of language to form words. Thirdly we will understand and create meaning out of the individual words in relation to each other, thus forming an understanding of each sentence. Finally we understand how sentences relate to each other in order to understand the full text. Therefore we need both to maintain information and also to process the information. The purpose of reading is ultimately to understand the text; the more working memory capacity that must be devoted to just processing the words the less is left to make meaning of what has been read.

The same applies to mathematics. If you are familiar with numbers and the rules of arithmetic (addition, subtraction, multiplication, etc.), you can handle more complex tasks. Children with working memory difficulties often struggle with learning digits and use strategies to facilitate arithmetic. Strategies, such as counting on fingers, can unfortunately take a lot of resources. This type of strategy can actually increase the burden on working memory and in the long run hinder the child rather than help.

COUNTING ON FINGERS PUTS HIGH DEMANDS ON WORKING MEMORY IN THE LONG RUN

Regarding adults, researchers have shown that working memory capacity affects how we solve different cognitive tasks that require cognition on a higher level. Among others, the American researcher Randall Engle, along with his colleagues, demonstrated that individuals with high working memory capacity perform better on tests measuring fluid intelligence and on standardized tests that measure academic ability.

INTELLIGENCE

Working memory has proven to be a key factor in reasoning and problem solving. Studies indicate that one third to a half of the variation between different individuals' performance on intelligence tests can be explained by working memory capacity. It has been a debate about whether working memory is just another way to measure the general intelligence (often referred to as small g) and that it really does not add any new useful information, and that working memory is not something that can be clearly distinguished from intelligence. A number of studies, however, indicate that working memory is an important measure that differs from general intelligence. Patricia Alloway et al, in a study from 2009 demonstrated that working memory capacity in children in primary and secondary school (7-12 years) was a better indicator than general intelligence in predicting performance in reading and maths two years after the measurements.

Whilst they are separate constructs working memory and intelligence are closely linked. Training of working memory should therefore theoretically lead to improvements on tests that measure intelligence. A study from 2008 replicated in 2010 by researchers Susanne Jaeggi et al. of normal intelligence adults, revealed that such improvements in performance on intelligence tests could indeed be found as a result of working memory training.

ATTENTION

Being able to maintain attention on one thing in practice requires a number of sub-tasks; choosing to focus on specific information for a short time, being able to shut out other information (inhibition) and to consciously shift attention. All these things are required when you perform activities that involve working memory.

There are several ways to describe attention. Much research has been conducted in this area, so there are a variety of models. Two types of attention are commonly described: intention-driven attention and stimulus-driven attention. Intention-driven attention means that we are actively trying to draw focus to something. For example, when we try to read a book, watch TV, listen to what someone says or solve a crossword puzzle, we direct our focus to the task that we want to do in the moment. Stimulus-driven attention is when our attention automatically turns to something in our environment. For example, if a car passes outside your window when you try to watch TV, and the car makes a very loud sound. Without actively choosing

it, your attention, for a moment, will be directed to the loud sound. This is a primitive function that is important in order to become aware of danger.

Alertness is usually mentioned as another aspect of attention. The more alert we are, the more easily we can remain attentive to the activity we are following. When we get tired, it may be almost impossible to stay fully attentive to a task. Think for example of how your attention works if you are extremely tired and are driving a car. The more tired we are, the more difficult it becomes to focus our attention.

THE IMPRESSIONS IN OUR ENVIRONMENT AND OUR ABILITY TO CLOSE THEM OUT AFFECTS THE POSSIBILITY TO MAINTAIN ATTENTION TO THE TASK AT HAND

There are several ways to measure working memory capacity. The two most common types of working memory tests are verbal and spatial.

Working memory tests can furthermore be divided into two subtypes: simple working memory tests such as digit span and complex working memory tests such as reading span. Simple tests primarily measure the ability to store information, while more complex tasks are also designed to measure the ability to process information. Since there is great consensus that working memory involves both storing and processing of information, many believe that the simple tests are insufficient to reliably measure working memory. Furthermore, it appears that complex working memory tasks can to a significantly higher degree be used to predict performance in relevant areas, such as reading comprehension and problem-solving skills.

Below we give examples of some commonly used tests designed to measure working memory capacity.

DIGIT SPAN

A traditional and still frequently used measure of working memory is to ask participants to repeat digits that have been read aloud. Usually capacity is tested both of repeating digits in the same order they were presented and in reverse order. On average, adults are capable of remembering about seven digits forwards and five digits backwards. The reason that it is more difficult to repeat digits backwards is that this requires both information storage and to some extent processing of the information. Digit span forwards measures only the storage capacity and thus not the ability to process information. A further limitation of measuring working memory in this way is that only digits are used and some of us may have difficulties particularly with interpreting digits.

READING SPAN & LISTENING SPAN

In the 1980's the researchers Meredith Daneman and Patricia Carpenter developed two verbal working memory tests called reading span and listening span. These tests are designed to measure the ability to store information as well as the ability to process information.

Reading span is tested by asking the participant to read a few sentences presented on small cards. The participant's task is to remember the last word in each sentence. The first series consists of three cards with two sentences on each card, the next level consists of three cards with three sentences on each, and so on up to a series of three cards with six sentences each. At each level there are three trials. First three sets of two sentences are presented. Then three sets of three sentences and so on. When a person fails all three attempts at a level his reading span is considered to be reached. This test is designed to require both processing (that you read a sentence) and storage (the last word in the sentence) and has been shown to be associated with tests that measure reading comprehension.

The listening span test is very similar to reading span. The difference is that in this test a series of statements are read aloud by the test leader. Your task as participant is to attempt to remember the last word in every statement, whilst also deciding whether each statement is true or false. To consider whether the allegation is true or false is an important component of the test to ensure that you as participant do not only focus on the last word in each statement. By asking you to answer the question whether the claim is true or false the test leader can verify that you actually processed the information in each statement.

TEST YOUR OWN READING SPAN

This is an example of how the "reading span" test can be conducted. Read one sentence at a time. After reading all the sentences in a series close the book again and try to remember the last word in the sentences. Here are examples of two different levels - three sentences and four sentences.

Note: Read each sentence only once!

Exercise 1: Read the three sentences and then close the book. What were the last words?

1. On the way home the child passed a restaurant.

2. When the sun rises the sky often has a beautiful colour.

3. There are many different definitions of working memory.

   Close the book!
   How did it go?

Exercise 2: Here is one a bit more difficult. Good luck!

1. When you work late it can sometimes help to eat some cake to stay alert.

2. Most of us go to the beach in summer time, but it is also very beautiful in the winter!

3. In hospitals, among others, nurses, doctors and cleaners work.

4. Writing a good book puts high demands on concentration.

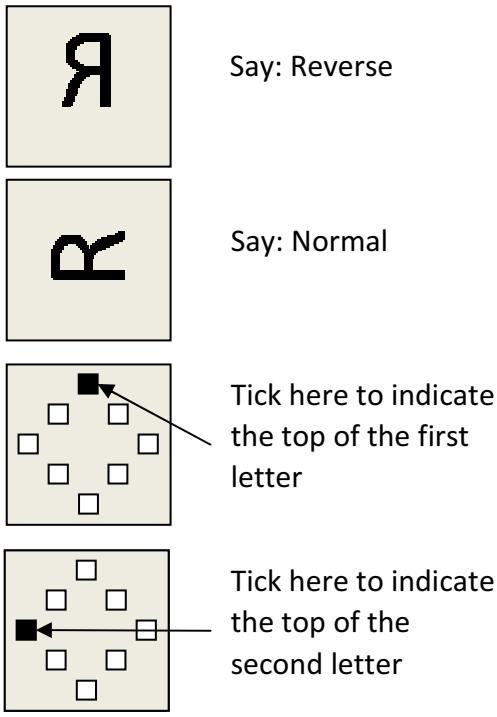
   Close the book!
   How did it go this time?

Answers: Exercise 1 = *restaurant, colour, memory.*
Exercise 2 = *alert, winter, work, concentration.*

SPATIAL SPAN TASK

Priti Shah and Akira Miyake have developed a test designed to equal reading span, in the sense that it measures both information storage and processing, but concerning spatial ability rather than verbal. The test is called the spatial span task. As a participant you are shown a series of letters. Your task is first to determine whether each letter is normal or reversed. Secondly you must remember which direction each letter pointed. The letters have their upper side in one of eight directions. The letters can consequently lean to the right or the left, upwards or downwards. You can, for example, see a series consisting of a normal R with the top to the left. Then you see another R which now is a mirror image with the upper side towards the left. First you will respond normal, then reverse. When you have done this you will be asked to mark in a grid in which direction the top of the letter was in each trial. The number of letters to classify as normal or reversed and which direction they point is gradually increased to test your maximum capacity.

FIGURE 6: EXAMPLE OF SPATIAL SPAN TASK



Some everyday activities involve more working memory and, if carried out regularly and intensely, may help to train your memory. One condition is that the activity is carried out frequently. For example, there is likely no evident effect on working memory if you play chess once a week. On the other hand, if you play chess almost every day it may have a positive impact on your working memory. Music and dance are other activities that involve working memory to a substantial degree. Crossword puzzles, although a method used for brain gymnastics by many, have in fact no clear link to working memory. Sudoku, by contrast, has a clearer link to working memory because it requires problem solving in several steps.

To train working memory through systematic intensive training is still a relatively new phenomenon and there is still some uncertainty as to why the training has effect. One theory is that the nerve cells activated during training are multimodal, i.e. they are not linked solely to one sense (one modality). This would consequently mean that visual training can also affect auditory ability. This is something that in recent years has actually been demonstrated in studies where training of only visual working memory has proven to have an effect on verbal working memory tests. Another current theory is that working memory training can have positive effects on abilities other than those trained only if they trigger the same brain areas that are activated by working memory training. Recent studies have also shown support for this theory, that the overlapping areas are activated when engaged in problem-solving as when training working memory. This is probably the reason why researchers have seen improvements in problem solving skills following working memory training. In the case of inhibition, scientists have not seen any impact as a result of working memory training, which is believed to be due to the fact that it does not activate the same specific brain area.

For cognitive training to be effective, it is first necessary to continuously adapt the level of difficulty according to the user's performance. This is necessary for the training to be constantly held at a level that is a maximum challenge for the user. Secondly, it is necessary for training to be performed regularly and over a sufficiently long time. The length of training that is long enough to have a strong effect is difficult to establish definitively. There are studies that have shown effects on attention capacity after as little as five days of training, but most studies suggest that a longer training period is necessary to achieve maximum effect. Approximately 20-25 days of training have in several studies shown significant effects.

ACTIVITIES THAT INVOLVE WORKING MEMORY TO A RELATIVELY HIGH EXTENT

EXPLORED AND UNEXPLORED GROUPS

Working memory training is a relatively new area and as a result only a limited amount of research has been done in this field. So far positive effects have been demonstrated for among others:

- Children with ADHD diagnosis
- Children and adults in the normal population
- Children with poor working memory
- Adults who have suffered from a stroke

However, there are a number of other diagnostic groups in which low working memory is a common problem, such as dyslexia, Down's syndrome and autism spectrum disorders There is still a great need for research in this area and we will certainly know more about who benefits from working memory training in the near future.

Below, general features for people with poor working memory, as well as people with ADHD (Attention-Deficit/Hyperactivity Disorder), are described and discussed. There is a large overlap between these two groups, however, poor working memory does not necessarily indicate that the criteria for ADHD diagnosis will be met, and an ADHD diagnosis does not necessarily imply impaired working memory.

CHILDREN WITH POOR WORKING MEMORY

Children with poor working memory capacity as primary deficit often have a consistently low capacity. i.e. whenever working memory ability is tested it will be at the same low level.

Usually these children have little difficulty with activities involving social interaction, except when it comes to group activities. Group activities place high demands on our working memory and for this group of children their working memory becomes overloaded; the children tend to become very passive and easily distracted when engaged in group activities. Problematic situations are for example class assembly and free play in groups during break times.

GROUP ACTIVITIES OFTEN PUT HIGH DEMANDS ON WORKING MEMORY

Another difficulty for these children is remembering and following instructions. Often the child will remember the start of an instruction and commence the task without any problems. But when the next step of the instructions is reached, the child has already forgotten what to do next, with the result that the child either gives up or guesses what to do next. It is also common for a single step in a process to be repeated several times, or that certain steps are skipped. This results in many opportunities for learning being lost when the rehearsal of a task is incomplete because the instruction is forgotten on the way. Long instructions are particularly difficult for these children.

Many activities require both storage and processing of information. This is difficult for children with poor working memory as they easily become overloaded. Often, double problems occur when first the task in itself requires too much working memory capacity. Secondly parts of the activity that for most children are automated will require attention-demanding strategies for children with poor working memory capacity. In order to remember and visualize various strategies are used that constitute an additional burden on working memory. An example of this is to count on your fingers when a mathematical problem is to be solved. This approach may facilitate the storage of information, but takes up a lot of working memory capacity. When it is time to move on in the problem solving process and begin processing the information in the task to be solved, the information required may already be forgotten.

Poor memory is rarely the problem described by teachers and parents regarding a child with poor working memory. It is more common that the problems described are that the child is easily distracted, has low self-esteem and short attention span. The children are often described as in their own world, always day-dreaming and having difficulty concentrating and listening. Usually, children with poor working memory have a generally poor development in school and fall behind in several subjects. Research from England indicates that approximately four out of five children with low working memory capacity have fallen behind in reading and/or mathematics. The children often experience a lack of control over their environment, leading to frustration and low motivation. In some cases this may lead to outbreaks reminiscent of the lack of impulse control in children with ADHD.

Another common difficulty connected to poor working memory is the inability to monitor the quality of ones work. As a result, these children often hand in unfinished tasks or tasks with many careless mistakes. This is thought to be partly connected to weak academic skills, but also has to do with difficulties in remembering instructions in detail. Yet another factor is a lack of creativity in solving problems. Children with poor working memory often find it hard to imagine new approaches for solving a problem.

It has also been shown that this group of children often loses interest in a task they start with when they notice that they no longer have a clear target for their actions. This leads to children's thoughts wandering off, which may be perceived as day-dreaming. What happens is that the memory becomes overloaded, focus is no longer on the problem at hand, and the mind wanders to other things. It is important to remember that many of the things that are perceived as resentment and neglect may really be due to a reduced memory capacity. Children with poor working memory are often perceived as not living up to their full potential, but the cause is often difficult to identify. Many of the problems stem from the weakness of working memory and there are many situations in which children are perceived as absent-minded, but in fact it may be an inability to remember information.

CONSIDER THIS!

When working with children with poor working memory it is important to try to adapt the environment and use different methods aiming at avoiding working memory overload. Otherwise there is a great risk that school is perceived as impossible and offers experiences of failure instead of learning opportunities.

To our knowledge, researchers have not systematically investigated the effects of poor working memory capacity in adults on the performance of everyday activities in a similar manner as has been done with children. However, much research has been carried out on adults that explore how working memory affects the ability to perform various cognitive tasks. It has, for example, been demonstrated that adults with short phonological span have poorer vocabulary and language-learning ability than those with longer phonological span. Another aspect that has been identified is that adults with lower working memory capacity have more difficulty preventing themselves from being disturbed by irrelevant information. The irrelevant information may come from outside, e.g. in the form of someone talking loud on the phone while you try to read the newspaper. Most common, however, is that irrelevant information is created by ourselves, when we connect new information to previous information that is no longer relevant. Moreover, it has been shown that adults with lower working memory capacity generally perform worse on tests measuring fluid intelligence and on standardized tests that measure academic ability.

ADHD - BACKGROUND

It is estimated that somewhere between three and six percent of all children in school fulfil criteria for ADHD diagnosis. In adults, it is estimated that the prevalence is approximately equal - about four to five percent. Although much research has been done in this area the underlying causes are not yet fully known. However, it appears that the reason for the development of ADHD is related to both heredity and environment. Much of the knowledge of the meaning of heredity and environment stems from studies of twins. It has been shown that the influential environmental factors seem to be things that twins do not share such as complications at birth. More general environmental factors such as parenting and peers have generally been shown to have less impact on the development of ADHD in an individual.

ADHD has a strong hereditary component. There are a number of genes that influence some of the symptoms of ADHD that are known, but much research remains to fully understand the underlying genetic causes. The genes that are known to be related to heredity of ADHD concern parts of the brain’s signal system. Weaknesses and changes in these transmitters affect the child's ability to regulate behaviour, which can cause symptoms in the form of lack of attention, impulsiveness and restlessness. Part of the problem is usually lack of executive functions such as planning, organization

and coordination. It also includes working memory difficulties, which is commonly part of the problem in children with ADHD.

Studies indicate that children with ADHD have, on the basis of Baddeley's model, deficiencies in various components of working memory. For example, it has been found that children with ADHD generally exhibit more difficulties concerning visuospatial working memory than verbal working memory. Furthermore, there are indications that working memory difficulties may vary depending upon the subtype of ADHD (for information about subtypes, see the next page). Children with ADHD of combined type often exhibit a lack of working memory capacity on a broad front, while those with primarily attention disorder mainly have difficulties in tasks that call for executive and visuospatial working memory capacity. Children with mainly hyperactivity/ impulsivity do not as often have working memory deficiencies.

RESEARCH HAS SHOWN THAT ADHD HAS A STRONG HEREDITARY COMPONENT

CHILDREN WITH ADHD

Although the difficulties that children with ADHD have can vary greatly, problems with attention and impulsivity are prominent. ADHD can have a negative effect on the ability to maintain social contacts and carry out school assignments. Behaviours associated with lack of attention can be: that the child will find it hard to listen to and follow adults' instructions, will often lose things needed for the activity in hand (pencil, book, toy, etc.), will often make careless mistakes in schoolwork or other activities, or will seek to avoid activities that require sustained mental effort (such as homework). Behaviours associated with lack of impulse control include: that the child often leaves its place in the classroom when expected to remain seated, the child answers before a question is finished, has extreme difficulties sitting still without moving the hands and feet or has difficulty awaiting their turn. For most children with ADHD the problems are more tangible in unstructured situations, in situations where self-monitoring is required and when performing tasks that are perceived as monotonous and boring. Another characteristic feature of these children is that they often exhibit a very uneven level of activity over time, which means that the child's performance can vary greatly from day to day and/or hour to hour.

CONSIDER THIS!

Children with ADHD often find it more difficult than other children to find a sense of order in life and therefore benefit from a clear structure in everyday life, both in school and at home.

GIRLS WITH ADHD

It is only in recent years that an increasing interest in ADHD in girls has developed. Based on population studies ADHD is estimated that it is about 1.5 to 4 times more common in boys than in girls. However, it is likely that these figures will be changed over time. A sign of this is that the proportion of girls who were diagnosed between the years 1995-2005 increased by 20-25%. The difficulties that girls display are more often associated with attention and concentration rather than hyperactivity, which may be a factor leading to girls with ADHD not always being as easy to identify. Furthermore, girls with ADHD more rarely display conduct disorder and aggressive behaviour compared with boys, which means they do not create such problems for the environment as boys. The impairment of girls, however, is generally the same as for boys, but girls with ADHD have less access to

medication or behavioural therapy than boys. This is hopefully something that is changing as a result of increased attention and knowledge of girls with ADHD among healthcare providers, schools and the public.

HOW IS DIAGNOSIS DECIDED?

For diagnosis of ADHD the individual must display a number of symptoms, which are described in the diagnostic manual DSM-IV used by clinicians and researchers worldwide. Symptoms are divided into two categories: inattention, and impulsivity/hyperactivity. To exhibit symptoms of ADHD is not sufficient for diagnosis. Symptom onset must be before age seven, symptoms must have been continuous over time and cause significant impairment in at least two environments such as home and school. There is no single method that is sufficient to establish an ADHD diagnosis. An investigation aiming at identifying ADHD should therefore consist of several components. Interviews with parents and teachers, rating scales, tests that measure the child's cognitive and developmental level are elements that should be included. Often the investigation is done in cooperation between several professions such as psychologist, psychiatrist, speech therapist and physiotherapist.

ADHD SUBTYPES

There are three subtypes of ADHD:

1. ADHD predominantly inattention, which means that at least 6 out of 9 criteria for inattention as described in DSM-IV are met, but fewer than 6 out of 9 criteria for hyperactivity/impulsivity. Approximately 30 percent of children with ADHD diagnosis belong in this category.

2. ADHD predominantly hyperactivity/impulsivity, which means that at least 6 out of the 9 criteria described in DSM-IV for hyperactivity/impulsivity are met, but fewer than 6 out of the 9 criteria for inattention. About 10 percent of children with ADHD are diagnosed with this subtype.

3. ADHD combined is the third subtype, which means that the child meets at least 6 diagnostic criteria from each of the two categories inattention and hyperactivity/impulsivity. About 60 % of children with ADHD belong to this subtype.

ADULTS WITH ADHD

When the diagnosis of ADHD was developed in the 1980s it was regarded as a developmental problem that children outgrew with age. Today, instead ADHD is regarded as a chronic diagnosis, which is often maintained into adulthood. Research indicates that at least half of those with ADHD symptoms as children continue to have it as adults, although the concrete problem areas change with age.

Adults with ADHD often have a reduced ability for planning and organization, impulse control and in prioritizing and maintaining an even level of activity. Common practical difficulties for adults with ADHD in everyday life can be paying bills, managing the home, keeping deadlines and prioritizing and organizing information at work. Most adults probably identify with these types of difficulties at times, but in order to be diagnosed with ADHD the difficulties must have been salient at least six months, been evident in childhood and lead to a clear impairment. Furthermore, other reasons for the difficulties must be ruled out.

CONSIDER THIS!

It is important to keep in mind that many individuals diagnosed with ADHD also find that there are positive qualities connected with the diagnosis such as innovative thinking, spontaneity, risk taking and curiosity.

For individuals with impaired working memory a number of actions can be of help. Firstly, there are interventions designed to reduce the load on working memory, such as customized education. Secondly, there are interventions that aim at enhancing working memory, such as working memory training. These two types of interventions can often be a great complement to each other and it is important to bear in mind that what may have a positive effect for a certain person with working memory difficulties may not have positive effects for another.

TABLE 1: EXAMPLES OF INTERVENTIONS AIMING AT COMPENSATING FOR WORKING MEMORY DEFICITS

INTERVENTION	FOR WHOM?	READING TIPS/ARTICLES
Adapted pedagogy	All children with poor working memory	Gathercole, S. E., Alloway, T. P. (2008). Working Memory and Learning. A Practical Guide for Teachers. London: SAGE Publications. www.york.ac.uk/res/wml/
Special aids (e.g. calendar/organiser and weekly schedule)	Children and adults	Barkley, R. A., Benton, C. M. (2010). Taking Charge of Adult ADHD: New York. The Guliford Press. www.ldonline.org
Parent training programs (e.g. COPE)	Parents who want tools to understand and handle their children's behaviour.	Cunningham, C. (2005). A large group community based family systems approach to parent training. In Attention-Deficit Hyperactivity Disorder. A Handbook for Diagnosis and Treatment. 2nd edition Ed. Barkley, R. New York: The Guilford Press.
Cognitive behavioural therapy for ADHD-symptoms	Adults diagnosed with ADHD	Safren, S. A, Perlman C. A, Sprich, S & Otto, M, W. (2005) Mastering your Adult ADHD – a Cognitive Behavioral Treatment Program. Oxford University Press* .

* The book is written for psychologists/therapists.

TABLE 2: EXAMPLE OF INTERVENTIONS THAT CAN IMPROVE WORKING MEMORY AND/OR RELATED FUNCTIONS

INTERVENTION	FOR WHO?	READING TIPS/ARTICLES
Medicine* (Methylphenidate and atomoxetine)	Children and adults diagnosed with ADHD	Information about ADHD and treatment can be found e.g. here: www.helpguide.org www.adhdnews.com
Working memory training	Children and adults with poor working memory	Klingberg T, Fernell E, Olesen PJ, Johnson M, Gustafsson P, Dahlström K et al. Computerized training of working memory in children with ADHD – a randomized, controlled trial. J Am Acad Child Adolesc Psychiatry 2005;44(2):177-86. Ivarsson, M., Strohmayer, S. (2010). Working memory training improves arithmetic skills and verbal working memory capacity in children with ADHD. Master's thesis. Stockholm. Stockholm University.
Non-computerized training of attention and memory functions (e.g. SMART*)	Children with specific attention and memory difficulties	van't Hooft, I., Andersson, K., Bergman, B., Sejersen, T., von Wendt, L., Bartfai, A. (2007) A randomized controlled trial on children with acquired brain injuries reveals sustained favorable effects of cognitive training. Neurorehabilitation, 22, 109-116.

*Does not primarily aim at enhancing working memory ability.

There are a number of other factors in addition to those mentioned above that profoundly affects one's ability to concentrate and one’s working memory capacity, whether you have been diagnosed with ADHD or not, such as diet, sleep, exercise and stress.

SLEEP CAN HAVE A BIG IMPACT ON OUR WORKING MEMORY CAPACITY

The following sections presents an overview of research on working memory training and experiences of the computer programs in the Memory Quest series.

RESEARCH ON WORKING MEMORY TRAINING

Research results from recent years indicate that the brain's plasticity and the effects of cognitive training are larger than has previously been believed. The previously dominant view of most researchers has been that cognitive training would lead to improved ability in the specific task alone and only in connection with the training of the specific task. In recent years, however, several different types of training that involve working memory have been shown to have transfer effects, i.e. effects on abilities other than those trained. Working memory training has resulted in improvements in e.g. problem-solving skills and mathematical ability. However, relatively little research has been conducted thus far regarding the long-term effects of working memory training. Studies have shown effects remaining up to one and half years after completion of training.

”THE RIGHT AMOUNT OF RESISTANCE”

In a randomized controlled trial by Torkel Klingberg et.al. at the Karolinska Institute (2005) the effects of working memory training for children 7-12 years with ADHD were explored. Children in both treatment and control group trained for about 40 minutes a day, five days a week, for a total of five weeks. In the treatment group the difficulty of the working memory training was adapted automatically based on the children’s performance, while the control group performed working memory exercises with a constant low level of difficulty.

The study showed that the treatment group significantly improved their performance, in comparison with the control group, on tests measuring verbal and visual working memory, response inhibition and problem solving. A very interesting finding in this study was the importance of difficulty adjustment for the training to have an effect. We can make a very simplified analogy with the exercise of our muscles in the body. If we do weight lifting in order to get enhanced strength in the biceps and for stronger arms it is not enough that we use a machine to exercise and that we do it regularly. It

also requires that we use the right weights and that we gradually increase the resistance/weight if we want the muscles to continue to grow.

”THE RIGHT TOOLS”

In a recent study Lisa Thorell et.al. (2009) compared inhibition training (exercises to reduce impulsivity), with working memory training for pre-school children who were 4-5 years old. Inhibition training consisted of several types of exercises. In two of the exercises the task was to provide an answer for a certain type of stimulus (fruit) and to refrain from giving answers when other stimuli such as animals were presented. In two further exercises the task was to give an answer as quickly as possible when a fruit was shown, but not if a stop signal appeared immediately after. In the last exercise a number of arrows were shown in a row and the children's task was to press the arrow on the keyboard corresponding to the direction of the arrow that was presented in the middle. In both the inhibition and the memory training groups the level of difficulty of the exercises was adapted based on the performance of the children.

The results showed that working memory training led to improvements in working memory tests (including non-verbal trained) and attention. No improvement was seen, however, as a result of inhibition training. Returning to the analogy of weight lifting, this study showed that it is not just about work out over time and with the right weight but also that it must be a "machine" that involves the correct muscles if we want to have an effect.

”SUFFICIENT TIME”

In a study from 2008 led by the Swiss researcher Susanne Jaeggi it was shown that working memory training can improve adults' performance on intelligence tests. The study also showed that the improvement on the tests appears to depend on the “dose”, i.e. more days (19 days) of working memory training resulted in greater improvements in intelligence tests than fewer (8 days). If we return to the weight lifting analogy once again, this study showed that it is not just about using the right tool and right weights, but also the need to train a sufficient number of times to get the best results possible.

EXPERIENCES OF MEMORY QUEST

As developers of the Memory Quest software we have been active in the two biggest evaluations of the software that have been made so far. Brief summaries of the evaluations are found in the next section.

SMALLER GROUP, BETTER EFFECT

During the autumn of 2007 and spring of 2008 an evaluation of Memory Games Junior (a predecessor to Memory Quest) was made on 55 school children who were 7-9 years old. The children in the study were randomly divided into control and training groups with performance evaluated with Raven's Matrices, a non-verbal intelligence test. The children in the exercise group trained with Memory Games for about 5 weeks in groups of varying size (between 2 and 8 children).

The evaluation showed that the training group significantly improved their performance, in comparison with the control group, on verbal and spatial working memory tests. The evaluation also revealed that the children who trained in pairs improved more than those who trained in larger groups. The study indicated that training with Memory Games seems to work better when fewer children train at the same time with a single coach, for the explored age group.

IMPROVED ARITHMETIC SKILLS

From autumn 2009 to spring 2010 we carried out an evaluation of Memory Games Senior (a predecessor to Memory Quest) on 21 children 6-10 years of age with ADHD. The children in the study were randomly divided into either a control or training group. All children trained for at least 20 days with a computer program at home, with their parents as coaches (children in the control group used a reading training program). Before and after the start of training the children were tested on various aspects of working memory. The children were also assessed with a series of tests measuring academic skills such as arithmetic and word decoding. Finally, a rating scale was used where the parents of the children were to assess the presence of ADHD symptoms in their children.

The children in the exercise group significantly improved their performance, in comparison with the control group, on tests measuring verbal working memory and arithmetic skills. In addition, parents rated a significant reduction in ADHD symptoms, both in terms of attention difficulties and hyperactivity/impulsivity. The decrease was not significantly greater in the exercise group than in the control group.

To summarize the evaluation indicated that training with Memory Games had a positive effect on mathematical ability and working memory capacity in children with ADHD.

PRACTICE

Here in the second part of the book we provide information about what factors to consider before training, during training, and after training. We also present practical tips and materials that can be used in connection with the working memory training. Further we give our thoughts on how motivation can be maintained during the whole training period and what to consider when evaluating the training. Finally, we present two case descriptions to demonstrate how working memory training can be conducted in practice.

TO TRAIN WORKING MEMORY

To train successfully with Memory Quest, careful preparations are essential. For maximum impact, it is important that the entire training period is carried out and that the person training is constantly trying to perform to his or her best ability. In the chapter “training materials” are checklists and charts, etc., that are meant to be an aid to training with Memory Quest.

Before you begin training, it is advisable to go through the training materials to ensure that no details of the planning have been forgotten. To get a clearer picture of how training materials can be practically applied, you can read the case descriptions in the next chapter.

We generally recommend that also adults who are going to train have someone who can help with preparations. If this is not possible or if you do not think it suits you, it is of course possible to train alone, but this puts higher demands concerning planning, motivation and endurance.

HOW DOES THE TRAINING WORK?

The actual training consists of a number of computerized exercises. The difficulty of the exercises is automatically adjusted to the individual's performance, so that the load on working memory is always at an optimal level. The first time someone trains, we recommend an exercise program that includes 20 or 25 training sessions. Each training session takes between 15 and 40 minutes depending on the selected programme, age and individual factors such as reaction time and how many items the individual is able to remember. During each training week 4-5 training sessions should be carried out resulting in a total duration of 5-7 weeks. If the trainee has experienced a positive effect from the training and wants do an additional

training period, it is a possible option. However, we recommend that the second training period begins no earlier than three months after the initial training period is completed.

COACH

The coach's main function is to help the person training to maintain motivation throughout the training by continuous support and feedback. The trainee will very likely, sometime during the training, complain that it is hard to train and show signs of reduced motivation. There are various ways to help the trainee to get through these motivational dips and to train even though it is inconvenient. However there is no general method that works for everyone. Each individual is motivated by different things and it is important that you trust your own teaching skills and use your experience of working with the person that you are supervising. The goal is that the trainee maintains maximum effort and continues training throughout the training period. It is best if one person can be responsible for training during the entire period to provide continuity, but also because the coach will then get a good understanding of what facilitates training for that trainee.

DIFFERENCES BETWEEN TRAINING WITH CHILDREN AND ADULTS

The role of coach usually differs between training children or adults. When a child is training, it is often necessary for the coach to sit with the child, actively providing support. The child often needs to have a coach present to maintain focus and concentration. As a coach of children it is worth maintaining praise for their endurance, reassuring them that they are trying their best. Furthermore, it is common that after a while the child gets used to the positive reinforcements that are included in the program so positive verbal reinforcement from the coach can be critical for continued motivation. The extent to which you need to be active varies from child to child and it is important to be sensitive to the needs of the particular child you are training with. The same applies to coaching an adult; your role as a coach can vary a great deal depending on the needs of the person training. Most adults manage to train alone, while some adults with special needs benefit from having the coach next to them. Regardless of how the support during the training is designed it is always good as coach to help with preparations and evaluation, and to continuously monitor the training process to make sure that all training is carried out.

LOCATION

Sometimes your choices are limited as regards the location for memory training. As with everything else you have to be realistic and make the best of what is available.

Perhaps the most important thing to consider when choosing location for training is that it is quiet. Preferably choose a secluded place where no one will turn up unannounced. If it happens that someone tries the door during training or that people often knock it quickly becomes an annoyance and something that will cause the trainee to lose concentration. Some of the time that could have been spent on training will be wasted. A good tip is to put a sign on the door such as "Memory training in progress, do not disturb!"

It is also good to have as bare of a room as possible. The fewer visual distractors the easier it is to focus. If training takes place in the home it may therefore be a good idea to clear the room chosen for training before the actual training begins. If possible training should, for the same reason, always be in the same room. This will create a safe environment with a limited number of new impressions and all the focus can be placed on training.

TO FACILITATE CONCENTRATION ON TRAINING IT CAN BE WISE TO REMOVE DISTRACTING OBJECTS

CONTINUITY

Continuity is a key word that should permeate the entire training. Ideally, the training should take place the same time of day, in the same room, with the same coach for each training session. Ability to concentrate can vary from day to day, but also depending on what time it is. Just before lunch, when blood sugar levels are low, or right after lunch when digestion is at work are times you should avoid memory training if possible. The same applies in the afternoon when a school day/business day draws to an end. It is best for most people to train in the morning; for example in the case of children to train shortly after they have started school. However, it is important to remember to always adjust the time according to what works best for the trainee. Always training at the same time of day means that similar conditions will be given for all training sessions. The risk of irregular training is that some days training will be carried out when memory ability is at its peak and some days when it is at its lowest; this can affect how it feels to train. If you have been training on Monday at a time when you feel that you cope well and then train on Tuesday after lunch and physical education the risk is that the training is less fun and that it is difficult to do one's best. It is a great advantage to train when individuals feel refreshed and alert in order to create a positive atmosphere for the training.

The coach has an important role in the success of working memory training, and by always having the same coach it is easier to keep track of developments in the training. As coach, you learn what kind of feedback works best, and when an individual needs the most support.

MOTIVATION

Motivation is central to memory training to have as good an effect as possible. A central aim of this book is to give you, as coach, relevant information about working memory. We hope it can help create a proper motivation in you as coach. It is also important to convey information to the trainee and to important people around them, so the training feels meaningful for everyone involved. If everyone involved is motivated, this will contribute to a better atmosphere for the training and increase the likelihood that training will be conducted well.

PRACTICAL TIPS

On the following pages practical tips are given on how training with Memory Quest can be facilitated. First there is a section for you as a prospective coach of a child training in school. Next follows a section for you as a prospective coach of an adult. Finally there is a section for those who will train alone.

CHILDREN

One of the first things you need to decide when a child will start working memory training is whether it will take place at home or at school. Our experience suggests that there are a number of advantages to locating the training to school. Here are some examples:

1. It can be easier to motivate a child to train in school because the child is used to doing things at school that are not always fun and that are strenuous.

2. It is often easier to find a regular time for training and to find a training time that is suitable for the child's optimal activity level.

3. School staff have experience and knowledge of how to motivate children with various difficulties.

4. Training will not be as sensitive to illness and other potential obstacles for training because it is easier to find a substitute coach in school.

5. It is often difficult to find a time of day at home when it is quiet. Especially if the trainee has siblings. At home there are also a number of other distractors such as TV, vacuum cleaner or kitchen fan that can have a negative effect on training.

6. There is finally also a risk for the training to lead to conflicts between child and parent when it does not work optimally.

We therefore recommend that the training takes place at school if possible. It should however be added that if your home provides the proper conditions and you as a parent can manage to set up a good training

environment in the home, it can be a positive activity that involves both child and parent. It is important that parents are aware that it is a comprehensive effort that will place great demands on both your own and your child's patience. It requires you to devote as much as an hour a day for training and preparations, so you must be able to do this without too much conflict and preferably, at the same time each day.

If you train at home, it is sometimes good if someone from school can provide coaching for you as coach to the child. It is also possible that a parent takes full responsibility for training, but this is more demanding. Regardless of where training takes place and who coaches the trainee, we recommend that you use the material in the chapter "training materials, children" as support.

REWARD SYSTEM

In many cases when working with children, encouragement and praise are enough to maintain motivation. Working memory training is often perceived as mentally demanding, and as a result, problems with motivation often occur at some point during training. A strategy to counter this and that has proven effective is to include a reward system. It is important to stress that the rewards should not consist of big things. Usually it is appropriate to let the parents implement the rewards, even if training takes place at school. Rewards must be reasonable but at the same time not too mundane. It is important that the rewards have a motivating effect on the child. Examples of rewards can be to rent a movie, play games together, get to stay up a little later on Friday night or go to the swimming pool together.

It is important to emphasize from the beginning that rewards are handed out after each five-day period of training that is completed. That the child is clear about this from the beginning means that the risk for conflicts diminishes. The parents should never threaten to take away rewards. It is also important that the rewards are always handed out on time and that agreements are kept on both sides. The objective of the reward system is to come up with something that the parents or the school feel is realistic and that really helps the child's motivation. As training becomes harder and the child often finds it more difficult to maintain motivation as training progresses, it is a good idea to rank the rewards that you choose. The first can be something small such as letting the child choose their favourite dish for dinner on Friday night. The last week maybe you will go to the movies together or do something else that the child is very fond of, but may not be able to do so often. Always ensure that the rewards are filled out in the logbook before training begins so that there are no misunderstandings during training. For guidance on how to go about selecting the appropriate rewards see Appendix 2.

THE LOGBOOK

There is a lot to keep track of before training can begin. The logbook serves several purposes, but the most important function is to make preparations for the training as easy as possible. The logbook contains the following things:

- Information to the child on working memory and working memory training.
- Reward schedule, where rewards are to be written before training begins.
- Overview of every week of training where the child fills out completed training days.
- Easy checklist that you as coach go through together with the child before training begins. A more extensive checklist can be found in this book in Appendix 1.

Always use a logbook when coaching a student training with Memory Quest to ensure control over training and to make sure that no details are overlooked.

The logbook can be downloaded from
www.memoryquest.co.uk

TRAINING SCHEDULE

The training schedule gives you as coach an overview of when and where training is to take place and who will be in charge of the training on each day (see Appendix 3). In the training schedule you should before training begins fill out the following:

- The location where training will take place.
- The dates when training is planned to be conducted.
- Who will coach each day of training?

TRAINING A PUPIL AT SCHOOL

As coach to a pupil in school, you should make preparations for what happens if you are sick. Be sure to have a temporary coach who has good understanding of the training and who can keep the training going when you are absent. It is also important that the staff in your team is aware that training will be carried out and that they give you their support so you do not encounter undue resistance on the way. Sometimes the pupil training must be absent from regular teaching/activities; this is another reason that the relevant staff at school should be informed. Before a child starts memory training in school, it is important to give the child and parents information about the training. Below are suggestions on how you can provide information on working memory and working memory training for children and their parents.

INFORMATION FOR CHILDREN

Working memory is probably a new concept for the children who will be training. As it can be difficult to explain to a young child what working memory is and what working memory training is, it is important to give the child as comprehensible an explanation as possible. It can be a good idea to use the logbook to assist you when you inform the child about working memory and the actual training.

INFORMATION FOR PARENTS

For most parents working memory and working memory training is as new as for their children. The information in the logbook can also be used to give parents an overview of how working memory functions. However, it is common that parents want to learn more about working memory and how the training practically works. The information in this book can be used as support to give them a deeper understanding. Parents usually implement the rewards that are linked to training and the more motivated parents are the easier it will be to carry out memory training effectively.

Before you start to train it is important that thorough preparations are made to create conditions for training to be as successful as possible. You must clarify what resources, possibilities and aims there are regarding training. One of the first things to consider is whether the training will take place at home or in the institution responsible for training.

For the training to take place at the institution responsible is in many cases positive, as structure and regularity will be easier to maintain. In some cases it can even be necessary for the adult to get started with each training session and to maintain motivation. Furthermore, if the adult has cognitive difficulties it can be required that you as coach need to sit next to the adult to enable training. However, we think that the majority of adults can carry out training at home on their own, even if it puts greater demands on them. It is therefore especially important when training takes place in the home that you as a coach provide regular support and help with necessary preparations. We recommend that you follow the checklist (Appendix 6) to make sure that all preparations have been made. It is important to write down everything that you then decide regarding training because the person training may have difficulties in remembering information presented orally.

INFORMATION FOR THE TRAINEE

To increase the motivation of the person training, we believe it is necessary to provide information on working memory and working memory training before starting training. Appendix 7 at the end of the book is a leaflet which we recommend that you as coach go through with the trainee. If someone wants more information you can lend this book or copy the chapters “working memory” and “working memory training”. Keep in mind that you should adjust the amount of information and how you present information based on the cognitive abilities of the person training. If the trainee has great difficulties with working memory, it can be appropriate to present information in small sections so that working memory is not overloaded unnecessarily. It is also good to let the trainee ask questions so that anything they are unsure of can be addressed. It may also be appropriate to ask questions of the trainee to ensure that all necessary information has been understood.

FINDING SOLUTIONS TO POTENTIAL OBSTACLES

After choosing the training location, giving information on how training is carried out and checking how it is perceived, it can be good to discuss possible obstacles to successful training. Below are a few examples of what can constitute an obstacle for an adult training in their home:

- I will forget to start training at the right time.
- I will not manage to complete the whole training period.
- I will not have the energy to train on Mondays.
- I will not be able to find a time when it is quiet at home and I have enough energy to train.

To manage these kinds of possible obstacles we suggest you use Appendix 9.

TRAINING AND REWARD SCHEDULES

Once you have found solutions to any possible obstacles it is time to fill out a training schedule and possibly write down things that come up that you need to do or think about to get the training to function as optimally as possible (Appendix 10).

In order for training to be carried out it can be useful to add a reward schedule. Working memory training is demanding and this may help to maintain motivation throughout the training period.

FOLLOWUP ON TRAINING IN THE HOME

To support those who train at home, it is appropriate to follow up on how training is going at least once a week. Appendix 11 - "Follow-up of training" presents what you should check and the questions you can ask the trainee. Monitoring can be done either at the institution responsible or via a phone call depending on what you as a coach consider appropriate in the situation. In order to create structure it is appropriate to determine the time and place for follow-up before the memory training begins and write it in the training schedule (Appendix 10).

How can you know that training has been helpful? In order to answer this, an evaluation may be of help. An evaluation may have several elements. One may be to go through how the training itself has been. Have there been any obstacles to training? Is there something that the person training has experienced as particularly positive or negative with the training? Another element is to check if training has had any impact. Has the person's behaviour in the classroom or at home/work changed? Does the person experience difference in his everyday life? For support and structure regarding evaluation we recommend that you use Appendix 4 for a child training and Appendix 11 for an adult.

EVALUATION – IS STARTED BEFORE TRAINING!

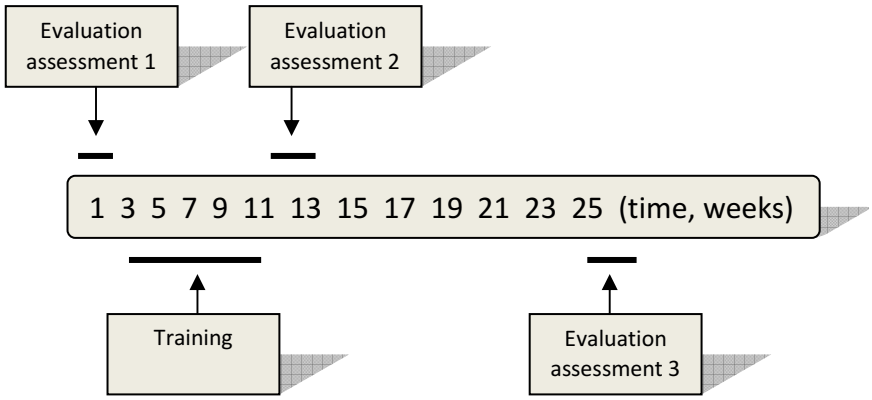
Before you as coach let the training with Memory Quest start, we recommend that you think through what measures you want to use for evaluation. This is necessary because some assessment methods require comparison of values before and after training. For example, if you as coach are interested to see if the parents and class teachers perceive differences in the concentration of the trainee it is easier to say something about that if you have collected data on how they perceived the trainee's attention span before the training began. In that case it is appropriate to distribute identical questionnaires to the assessors before and after training to be able to draw stronger conclusions about the possible training effect.

Below are the tools available in Memory Quest described: "Forms" and "Results from exercise programmes."

FORMS IN MEMORY QUEST

Forms are a very useful tool to evaluate change in behaviour in the trainee. It is important that the chosen form is filled out by the assessors on more than one occasion for you to get a clearer picture of effects of training. The best strategy is to make an assessment before training begins, the next assessment after completed training and a final assessment a few months later.

FIGURE 7: EVALUATION WITH 3 ASSESSMENT POINTS



Often it is good to use more than one assessor to get a better idea of training effects. For example, if an adult trains, you may want to have a partner, colleague and the adult him/herself assess behaviour. Having more assessors allows you to get an idea of behavioural change in different environments and to get different views of what changes may have occurred. In Memory Quest there is a menu for assessment that, in a simple way, helps you use forms for evaluation. Here you can save, print and see the tables of results from completed forms. The assessment tool is a set of ready-made forms that you can choose from. The forms concern areas where effects of working memory training have previously been proven (working memory, attention and hyperactivity). In the evaluation menu in Memory Quest you also have the possibility to create custom forms according to your wishes. This can be useful if there are additional behaviours, in addition to those presented in the standard forms, that you are interested in investigating. Note that the forms in Memory Quest are not standardized and are not intended to identify if problems exist in the first place. For a list of commonly used standardized assessment forms which concern attention, impulsivity and working memory see Appendix 13.

RESULTS IN MEMORY QUEST

It is important to note that the results in Memory Quest should be seen as one of several sources of information to evaluate training. The results of the training programme show whether the trainee has learned to remember longer series of stimuli and if they can remember longer sequences more frequently the longer the training has been conducted. To get a general idea of how training has gone, we recommend that you compare the results from the first training week with results from the last week of training. This will be automatically presented in the program when training is completed in the "gathered results" form. Based on evaluations conducted on Memory Quest an average increase of about 1 in "max items" indicate a positive change. An increase of two or more “max items” indicates a very big change.

NEUROPSYCHOLOGICAL TESTS

Training can also be evaluated using neuropsychological tests measuring working memory capacity and/or other related cognitive abilities. Most common is that neuropsychological testing is done in research, but not in everyday life. Most tests that measure neuropsychological functions require that a licensed psychologist administer them and therefore it is far from everyone that trains working memory that may be offered this type of element in the evaluation. However, we think that in most cases neuropsychological testing is not necessary to evaluate training if estimates of relevant behaviour are carried out systematically with forms. In Appendix 13, there are examples of how various factors can be evaluated using neuropsychological tests (mainly targeted at people who are certified Psychologists).

QUALITATIVE INTERVIEW

Once training is completed, it is advisable that you meet the trainee to gauge how they have experienced the training. Firstly this should give you information about any improvements in areas other than those assessed in the evaluation. Secondly, you may want to give the opportunity for the trainee to describe how they experienced training. Describing his/her experience of training confirms the effort of the trainee and provides an opportunity to discuss any difficulties. It can also give you information on how you can develop as a coach. In Appendix 4 and 12 we give tips on questions to ask children and adults who have completed training.

CONCLUSIVE COMMENTS

Finally, your subjective opinion as a coach is also important to remember. The idea of any systematic evaluation is to provide an objective picture of possible changes. The downside is that it is restrictive and if the right questions are not asked, or if you fail to observe a particular behaviour, actual changes as a result of training can be missed. The contact between the coach and the trainee is very important for there to be room for a productive conversation about training after it is completed.

CASE DESCRIPTIONS

To get an idea of how working memory training is typically conducted, we present two examples. In the case descriptions below are examples of how some of the appendices look when they are filled out. Forms for copying are at the end of the book.

CASE DESCRIPTION 1: JACOB, 7 YEARS

Jacob is in Year 2 and for some time now has found it difficult to concentrate at school. In an assessment by the school psychologist, it is evident that working memory is a particularly weak point for Jacob. In the classroom, this is evidenced by the fact that Jacob has difficulty understanding instructions and often remains seated at his desk when a task has started. At the beginning of Year 2 he often asked what to do, but now he usually just remains seated, as he often experienced that the teacher was annoyed that he did not understand what he should do. Now Jacob often sits and daydreams and is in his own world, seemingly uninterested in school work. Sometimes he raises his hand when the teacher asks something, but usually he does not remember what to say when he gets a chance to answer. Jacob sometimes forgets to take off his coat when he comes in from break and plays mostly with one friend at a time during the break. He rarely participates voluntarily in group activities during breaks.

Teachers have monthly supervision with Thor, the school's special educational needs teacher, who provides support for Jacob in school. He suggests that Jacob should be offered working memory training at school. In about one week, there is a week's holiday and it is decided that Jacob should start with the training directly after the holiday and carry out training for five weeks. Jacob's parents are contacted and receive information about training and how Thor thinks it can be of assistance to Jacob. It is decided that Thor will be Jacob's coach and that training should take place at 9 every morning in a room used by the special educational needs teachers at school. During one week of the scheduled training, Thor will be on holiday. For this week, Linda, who works as a support teacher in Jacob's class, will be Jacob's coach. Linda will also be available as a substitute for Thor if he is sick. Parents are positive about the intervention and assume responsibility for Jacob's rewards which will be implemented at home. As part of evaluating the training Jacob's father, class teacher and special educational needs teacher will assess attention problems with a form from Memory Quest, before training, immediately after training and three months after training.

Before it is finally decided that Jacob will start working memory training Thor has a conversation with Jacob to describe how the training works and how it can help him. Jacob thinks it sounds exciting and wants to do the training. Before training begins Thor copies the Appendices 1-4 and fills out all the relevant information to ensure that working memory training will be as smooth as possible (see next page).

Training is carried out as planned and Jacob works hard to do his best. At the end of the training Jacob sometimes has problems with motivation, but gets much support both from Thor and from his parents. Jacob says that he feels it is easier to concentrate on what the teacher says and that he experiences difficulties with following the teacher's instructions less often. The results of evaluations and the results of the training programme imply similar results so it appears that training has had a positive impact.

RESPONSIBLE COACH: Thor

NAME: Jacob

STAFF*	COMPLETED	COMMENTS
Assign substitute coach (in the event of the responsible coach being absent).	5/2	Linda, will supervise training if Thor is absent.
Inform others in the work team that training must be prioritized.	6/2	Colleagues seemed positive.
LOCATION	**COMPLETED**	**COMMENTS**
Choose location for training	5/2	The room by the library
Warn others that you must not be bothered (put a sign on the door, see Appendix 4).	5/2	Printed sign.
Remove potentially distracting objects	5/2	Removed books from table and put on shelf
PARENTS*	**COMPLETED**	**COMMENTS**
Inform parents about training and receive consent.	3/2	Parents positive and interested
Inform parents of the importance of continuous training.	3/2	The parents will try to remember to praise Jacob for his efforts.
Inform parents of reward system if they are responsible for rewards.	3/2	The parents are responsible for rewards. Logbook to be sent home so the parents can keep track of training.

**NOT APPLICABLE IF YOU AS PARENT ACT AS COACH.*

THE CHILD	COMPLETED	COMMENTS
Inform the child about how and why to train.	4/2	
Talk to the child about the importance of always trying their best	4/2	
Tell the child about the reward system and rules for rewards.	4/2	
TRAINING SOFTWARE	**COMPLETED**	**COMMENTS**
Try the software on the computer to be used.	5/2	
Create a profile* together with the child.	5/2	
Write in the training schedule when training will take place. (Appendix 3).	5/2	
REWARDS	**COMPLETED**	**COMMENTS**
Decide who will be responsible for rewards.	3/2	Parents responsible for handing out rewards
Choose rewards (see Appendix 2) and write in logbook.	3/2	Was done together with parents.
EVALUATION**	**COMPLETED**	**COMMENTS**
Decide how to evaluate and make appointments for evaluation (see Appendix 4 for support if needed).	4/2	Father, class teacher and special needs teacher will fill out forms on attention difficulties.

**READ THE MANUAL FOR THE SOFTWARE ON HOW TO CREATE A PROFILE. ** READ SECTION ON EVALUATION IN THIS BOOK FOR MORE INFORMATION.*

CREATE REWARD SCHEDULE

1. Write all rewards you can think of below.		
2. Remove unrealistic rewards.		
3. Let the child choose five rewards.		
4. Rank the five chosen rewards.		
5. Write the chosen rewards in the logbook.		
Suggestions of rewards	**Chosen** (mark 5 with X.)	**Rank** (1-5) 1 = Most valued 5 = Least valued
Choose movie on Friday night	X	3
Play football with mum and dad	X	4
Go to the cinema	X	2
Get computer game		
Ice cream from the ice cream bar	X	5
Sleep-over with Oscar	X	1
Go for pizza		

RESPONSIBLE COACH: Thor

NAME: Jacob

ENTER DATE & TIME WHEN TRAINING IS PLANNED. USE A PENCIL TO BE ABLE TO ERASE AND CHANGE IT IF TRAINING IS NOT COMPLETED ACCORDING TO PLAN.

Week 1

Day	Date	Time	Coach	Comments
1	11/2	09:00	Thor	
2	12/2	09:00	Thor	
3	13/2	09:00	Thor	
4	14/2	15:30	Thor	Not possible morning time.
5	15/2	09:00	Thor	

Week 2

Day	Date	Time	Coach	Comments
6	18/2	09:00	Thor	
7	19/2	09:00	Thor	
8	20/2	09:00	Thor	
9	21/2	15:30	Thor	Not possible morning time
10	22/2	09:00	Thor	

Week 3

Day	Date	Time	Coach	Comments
11	25/2	09:00	Linda	
12	26/2	09:00	Linda	
13	27/2	09:00	Linda	
14	28/2	15:30	Linda	Not possible morning time.
15	1/3	09:00	Linda	

Week 4

Day	Date	Time	Coach	Comments
16	4/3	09:00	Thor	
17	5/3	15:00	Thor	Class excursion
18	6/3	09:00	Thor	
19	7/3	15:30	Thor	Not possible morning time.
20	8/3	09:00	Thor	

Week 5

Day	Date	Time	Coach	Comments
21	11/3	09:00	Thor	
22	12/3	09:00	Thor	
23	13/3	09:00	Thor	
24	14/3	15:30	Thor	Not possible morning time
25	15/3	09:00	Thor	

RESPONSIBLE COACH: Thor

NAME: Jacob

PART 1: EVALUATE EFFECTS OF TRAINING

1. Decide what the evaluation aims at investigating, i.e. what factors you are interested in assessing. Examples of factors can be “concentration” or “mathematical ability”.

2. Next, we recommend that you choose what tools to use to evaluate each factor. In the ”Extra information” section at the end of this book there are examples of how different aspects can be assessed.

3. Decide who will participate in evaluating each factor. To evaluate the factor “concentration” it can, for example, be appropriate for both teachers and parents complete questionnaires.

4. Decide dates for evaluation assessment point 1 (before training), point 2 (after training) and point 3* (follow up).

Factor	Tool	Participant	Time (assessment point)			Comments
			1	2	3*	
Attention	Questionnaire “Inattention, student”	1.Father, 2.Class teacher 3.Special teacher	5/3 to 7/3			Print questionnaires for everyone

** A THIRD ASSESSMENT POINT IS NOT MANDATORY*

PART 2: EVALUATE HOW THE CHILD HAS EXPERIENCED TRAINING

Below are questions that you can ask to evaluate the training experience. You can also add questions.		
Question	Answer	Reflections
What do you think was good about the training?	I find it easier to follow teacher's instructions.	
What do you think was bad about the training?	Last week of training was very hard work.	
Was there anything that made the training difficult?		Chose not to use this question.
What was it like getting your rewards?	It was fun, but difficult to wait.	
Have you experienced any changes in school after training?		Asked class teacher instead.
Have you experienced any change at home after training?		Asked parents instead.
Your own questions	Answer	Reflections

** WHAT QUESTIONS TO ASK SHOULD BE ADAPTED BASED ON THE CHILD'S AGE.*

Maria has, for most of her life, had problems with both lack of attention and poor impulse control. Ten years ago Maria had a daughter with her husband Henry. In recent years her problems have had an increasingly negative impact on Maria's home life as well as her professional life. Maria often forgets to fill out forms that her daughter brings home from school and is often late or completely forgets to attend parent meetings at school. At work, Maria has difficulty organizing, often does things at the last minute, or forgets things she has promised to do.

Some time ago Maria sought help from adult psychiatry and has since been in contact with Lisa who is a licensed psychologist. Lisa has not provided a diagnosis, but using neuropsychological tests, has concluded that Maria has great problems with tasks putting demands on working memory. Lisa suggests that Maria can use various aids to reduce load on working memory, but also suggests that Maria should try working memory training. Maria is positive about the training and they agree to start.

The training will take place at home with weekly contact between Maria and Lisa. As they meet for therapy every two weeks, part of the follow-up during training will be in the form of telephone calls. They will also be able to devote part of a couple of therapy sessions to discuss how the training progresses.

Maria and Lisa use the checklist to plan the training. They also use the reward schedule and problem-solve to anticipate possible obstacles to training. For evaluation they decide to use the form in Memory Quest with questions about attention and impulse control. Maria and her husband will answer the questionnaires both before and after training.

The training goes smoothly and Maria experiences positive changes in her functioning while still training. The evaluative questions confirm that both Maria and her husband are experiencing positive changes in Maria's attention.

CHECKLIST

NAME: Maria

RESPONSIBLE COACH: Lisa

PREPARATIONS	COMPLETED	COMMENTS
Inform the person training about working memory and working memory training. (Appendix 7).	1/9	Maria received a copy of a text on working memory and working memory training that she will read until our next session.
Decide location for training.	1/9	At Maria's home
Choose training program.	1/9	Standard
Write in the training schedule when training will be carried out.(Appendix 10)	8/9	
Choose rewards (Appendix 8) and write in training schedule (Appendix 10).	8/9	
Decide time and place for follow up and enter in training schedule (Appendix 10).	8/9	Follow-up via telephone and in therapy sessions
Decide how to evaluate and what measures are to be used: see section on evaluation for more information.	1/9	Questionnaires: "inattention and impulsivity" from Memory Quest. Maria and her husband to complete.
Make appointments for all evaluations	8/9	Two assessment appointments

CREATE REWARD SCHEDULE

1. Write all rewards you can think of below.
2. Remove unrealistic rewards.
3. Choose five rewards.
4. Rank the five chosen rewards.
5. Enter the chosen rewards in the training schedule (Appendix 10)

Suggested rewards	**Chosen rewards** (mark 5 with x)	**Rank** (1-5) 1 = Most valuable 5 = Least valuable
Go out for breakfast on a weekday	X	3
Buy favourite magazine	X	4
Ice cream for dessert	X	5
Go to the cinema with friend	X	2
Go to museum with my husband	X	1

FIND SOLUTIONS TO OBSTACLES HINDERING TRAINING

1. First of all, it is important to define what could be an obstacle. Try to be as concrete and specific as possible. It is important to only work with one obstacle at a time. If there are multiple obstacles, we recommend that you use a separate schedule for each obstacle.

2. Try together to come up with as many solutions as possible, without reflecting on the pros and cons of each solution. The more solutions you can think of the greater the opportunity to find useful solutions. Write all suggestions in the chart.

3. Discuss and write down pros and cons for each solution. Remember that it is good to be as realistic as possible when describing the advantages and disadvantages. It is, for example, important to acknowledge if some solutions would constitute emotional barriers, such as being perceived as very difficult or boring.

4. Let the trainee estimate how likely it is that each solution will work/help (1 not at all likely, 10 very likely).

5. Pick out the solution or the solutions that were estimated as most probable, and add it/them in the checklist. Sometimes it may be of help to combine different solutions but it is most often best to have one clear and simple solution.

Potential obstacle for training:

Will forget to start training on time.

Suggested solutions	Pros	Cons	Estimate (1-10)
Set an alarm on my mobile phone 15 minutes prior to training.	An easy way to be reminded	Must have mobile phone on - sometimes have it on silent or shut off	6
Tell my husband to call home 15 minutes prior to training.	Always hear the phone	Troublesome for my husband, and he can forget.	3
Set an alarm on my wrist watch 15 minutes prior to training	Always have my watch on me	Must learn how to set alarm (will ask daughter for help)	8

NAME: Maria

RESPONSIBLE COACH**:** Lisa

1. ENTER DATE & TIME WHEN TRAINING IS PLANNED. USE A PENCIL TO BE ABLE TO ERASE AND CHANGE IF TRAINING IS NOT COMPLETED ACCORDING TO PLAN.

2. ENTER REWARDS, IF APPLICABLE, FROM APPENDIX 8.

3. ENTER TIME FOR FOLLOW UP.

Week 1

Day	Date	Time	Coach	Comments
1	21/9	16:00	-	
2	22/9	16:00	-	
3	23/9	16:00	-	
4	24/9	16:00	-	
5	25/9	16:00	-	
Reward week 1				
Ice cream for dessert				
Follow up		Time	Place	Comments
		25/9 15:40	At home, telephone	

Week 2

Day	Date	Time	Coach	Comments
6	28/9	16:00	-	
7	29/9	16:00	-	
8	30/9	09:00	-	Amnesty in the afternoon
9	1/10	16:00	-	
10	2/10	16:00	-	
Reward week 2				
Buy favourite magazine				
Follow up		Time	Place	Comments
		2/10 14:00	At Lisa's office	

Week 3

Day	Date	Time	Coach	Comments
11	5/10	16:00	-	
12	6/10	16:00	-	
13	7/10	16:00	-	
14	8/10	16:00	-	
15	9/10	16:00	-	
Reward week 3				
Go out for breakfast on a weekday				
Follow up		Time	Place	Comments
		8/10 15:40	At home, telephone	Thursday instead of Friday!

Week 4

Day	Date	Time	Coach	Comments
16	12/10	16:00	-	
17	13/10	16:00	-	
18	14/10	16:00	-	
19	15/10	16:00	-	
20	16/10	16:00	-	
Reward week 4				
Go to the cinema with friend				
Follow up		Time	Place	Comments
		16/10 14:00	Lisa's office.	

Week 5

Day	Date	Time	Coach	Comments
21	19/10	16:00	-	
22	20/10	09:00	-	Dentist 16:00
23	21/10	16:00	-	
24	22/10	16:00	-	
25	23/10	16:00	-	
Reward week 5				
Go to a museum with my husband				
Follow up		Time	Place	Comments
		23/10 15:40	At home, by telephone	Note time for follow up

NAME: Maria

RESPONSIBLE COACH: Lisa

PART 1: EVALUATE EFFECTS OF TRAINING

1. Decide what the evaluation aims at investigating, i.e. what factors you are interested in assessing. Examples of factors can be “concentration” or “mathematical ability”.

2. Next, we recommend that you choose what tools to use to evaluate each factor. In the “Extra information” section at the end of this book there are examples of how different aspects can be assessed.

3. Decide who will to participate in evaluating each factor. To evaluate the factor “concentration” it can, for example, be appropriate for both teachers and parents complete questionnaires.

4. Decide dates for evaluation assessment point 1 (before training), point 2 (after training) and point 3* (follow up).

Factor	Tool	Participant	Time (assessment point)			Comments
			1	2	3*	
Attention and impulsivity	Questionnaire “Inattention and impulsivity, adult”	1.Maria 2.Henry (husband)	1/9 to 8/9	27/10 to 3/11		Print forms to send home with Maria

** A third assessment point is not mandatory*

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APPENDICES

TRAINING MATERIAL - CHILDREN

TRAINING MATERIAL - ADULT

EXTRA INFORMATION

APPENDIX 1 - CHECKLIST

RESPONSIBLE COACH: _____

NAME: _____

STAFF*	**COMPLETED**	**COMMENTS**
Assign substitute coach (in the event of the responsible coach being absent).		
Inform others in the work team that training must be prioritized.		
LOCATION	**COMPLETED**	**COMMENTS**
Choose location for training		
Warn others that you must not be bothered (put a sign on the door, see appendix 4).		
Remove potentially distracting objects		
PARENTS*	**COMPLETED**	**COMMENTS**
Inform parents about training and receive consent.		
Inform parents of the importance of continuous training.		
Inform parents of reward system if they are responsible for rewards.		

** NOT APPLICABLE IF YOU AS PARENT ACT AS COACH.*

THE CHILD	COMPLETED	COMMENTS
Inform the child about how and why to train.		
Talk to the child about the importance of always trying their best		
Tell the child about the reward system and rules for rewards.		
TRAINING SOFTWARE	**COMPLETED**	**COMMENTS**
Try the software on the computer to be used.		
Create a profile* together with the child.		
Write in the training schedule when training will take place. (Appendix 3).		
REWARDS	**COMPLETED**	**COMMENTS**
Decide who will be responsible for rewards.		
Choose rewards (see Appendix 2) and write in logbook.		
EVALUATION**	**COMPLETED**	**COMMENTS**
Decide how to evaluate and make appointments for evaluation (see Appendix 4 for support if needed).		

**READ THE MANUAL FOR THE SOFTWARE ON HOW TO CREATE A PROFILE. ** READ SECTION ON EVALUATION IN THIS BOOK FOR MORE INFORMATION.*

APPENDIX 2 – CREATE REWARD SCHEDULE

1. Together with the child write all rewards you can think of below.		
2. Remove unrealistic rewards.		
3. Let the child choose five rewards.		
4. Rank the five chosen rewards.		
5. Write the chosen rewards in the logbook.		
Suggestions of rewards	**Chosen** (mark 5 with X.)	**Rank** (1-5) 1 = Most valued 5 = Least valued

APPENDIX 3 – TRAINING SCHEDULE

RESPONSIBLE COACH:_____

NAME:_____

ENTER DATE & TIME WHEN TRAINING IS PLANNED. USE A PENCIL TO BE ABLE TO ERASE AND CHANGE IF TRAINING IS NOT COMPLETED ACCORDING TO PLAN.

Week 1

Day	Date	Time	Coach	Comments
1				
2				
3				
4				
5				

Week 2

Day	Date	Time	Coach	Comments
6				
7				
8				
9				
10				

Week 3

Day	Date	Time	Coach	Comments
11				
12				
13				
14				
15				

Week 4

Day	Date	Time	Coach	Comments
16				
17				
18				
19				
20				

Week 5

Day	Date	Time	Coach	Comments
21				
22				
23				
24				
25				

APPENDIX 4 - EVALUATION

RESPONSIBLE COACH:_____

NAME:_____

PART 1: EVALUATE EFFECTS OF TRAINING

1. Decide what the evaluation aims at investigating, i.e. what factors you are interested in assessing. Examples of factors can be “concentration” or “mathematical ability”.
2. Next, we recommend that you choose what tools to use to evaluate each factor. In the “Extra information” section at the end of this book there are examples of how different aspects can be assessed.
3. Decide who will participate in evaluating each factor. To evaluate the factor “concentration” it can for example be appropriate that both teachers and parents complete questionnaires.
4. Decide dates for evaluation assessment point 1 (before training), point 2 (after training) and point 3* (follow up).

Factor	Tool	Participant	Time (assessment point)			Comments
			1	2	3*	

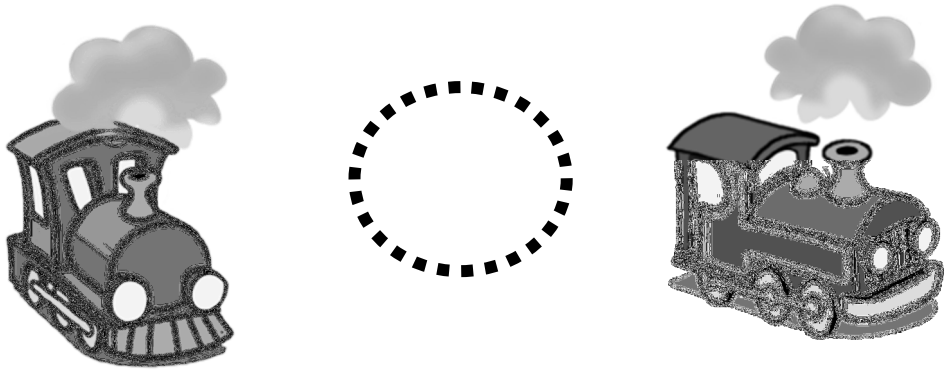
** A THIRD ASSESSMENT POINT IS NOT MANDATORY*

PART 2: EVALUATE HOW THE CHILD HAS EXPERIENCED TRAINING

Below are questions that you can ask to evaluate the experience of training. You can add your own questions.		
Question	Answer	Reflections
What do you think was good about the training?		
What do you think was bad about the training?		
Was there anything that made the training difficult?		
What was it like getting your rewards?		
Have you experienced any changes in school after training?		
Have you experienced any change at home after training?		
Your own questions	Answer	Reflections

** WHAT QUESTIONS TO ASK SHOULD BE ADAPTED BASED ON THE CHILD'S AGE.*

WORKING MEMORY TRAINING IN PROGRESS!



PLEASE DO NOT DISTURB

APPENDIX 6 - CHECKLIST

RESPONSIBLE COACH:_____

NAME:_____

PREPARATIONS	COMPLETED	COMMENTS
Inform the person training about working memory and working memory training. (appendix 7).		
Decide location for training.		
Choose training program.		
Write in the training schedule when training will be carried out.(Appendix 10)		
Choose rewards (Appendix 8) and write in training schedule (Appendix 10).		
Decide time and place for follow up and enter in training schedule (Appendix 10).		
Decide how to evaluate and what measures are to be used: see section on evaluation for more information.		
Make appointments for all evaluations		

WORKING MEMORY

Working memory is a fundamental cognitive function that is necessary for us to perform a number of mental activities, such as reading, counting and problem-solving. With the help of working memory we can maintain and process a limited amount of information for a short time. In other words, working memory is our ability to keep things in mind in “real time”. For example, we use working memory when we remember a phone number or when we follow an instruction. With a good working memory we can better concentrate and deal with distractions. Evaluation of the Memory Quest program suggests that training can lead to improved working memory and mathematical ability.

WORKING MEMORY TRAINING

The training consists of a number of computerized exercises that you should complete at each training session. The difficulty of the exercises is automatically adjusted according to your performance, so that the demands on working memory are always at an optimal level. The first time you train, we recommend a training program that contains either 20 or 25 training sessions. Each training session usually takes from 25 to 40 minutes depending on the selected program. During each training week you should carry out 4 to 5 training sessions so that the total length of the training period is 5 to 7 weeks.

The training itself is perceived by most as stimulating, but also very demanding. In order to maintain motivation throughout the training it may be helpful to use a reward system. Your coach will help you with this if you want, and with all other preparations to make sure the training is as beneficial as possible. During the training period, you will also have regular contact with your coach who will help you to maintain structure and focus.

Before you start training it is possible that your coach might suggest that you fill out a questionnaire and/or do psychological tests. This is to make it easier to evaluate the impact of your training after you have completed it.

For working memory training to have the best effect possible it is important that you always try to achieve your best. If you find things hinder you in your training you should, as quickly as possible, take it up with your coach to find solutions.

Good luck training!

APPENDIX 8 - CREATE REWARD SCHEDULE

1. Write all rewards you can think of below.
2. Remove unrealistic rewards.
3. Choose five rewards.
4. Rank the five chosen rewards.
5. Enter the chosen rewards in the training schedule (Appendix 10)

Suggested rewards	**Chosen rewards** (mark 5 with x)	**Rank** (1-5) 1 = Most valuable 5 = Least valuable

APPENDIX 9 – FIND SOLUTIONS TO OBSTACLES HINDERING TRAINING

1. First of all, it is important to define what could be an obstacle. Try to be as concrete and specific as possible. It is important to only work with one obstacle at a time. If there are multiple obstacles, we recommend that you use a separate schedule for each obstacle.

2. Try together to come up with as many solutions as possible, without reflecting on the pros and cons of each solution. The more solutions you can think of the greater the opportunity to find useful solutions. Write all suggestions in the chart.

3. Discuss and write down pros and cons of each solution. Remember that it is good to be as realistic as possible when describing the advantages and disadvantages. It is, for example, important to acknowledge if some solutions would constitute emotional barriers, such as being perceived as very difficult or boring.

4. Let the trainee estimate how likely it is that each solution will work/help (1 not at all likely, 10 very likely).

5. Pick out the solution or the solutions that were estimated as most probable, and add it/them in the checklist. Sometimes it may be of help to combine different solutions but it is most often best to have one clear and simple solution.

Potential obstacle for training:

Suggested solution	Pros	Cons	Estimate (1-10)

RESPONSIBLE COACH:_____

NAME:_____

1. ENTER DATE & TIME WHEN TRAINING IS PLANNED. USE A PENCIL TO BE ABLE TO ERASE AND CHANGE IF TRAINING IS NOT COMPLETED ACCORDING TO PLAN.

2. ENTER REWARDS, IF APPLICABLE, FROM APPENDIX 8.

3. ENTER TIME FOR FOLLOW UP.

Week 1

Day	Date	Time	Coach	Comments
1				
2				
3				
4				
5				
Reward week 1				
Follow up		Time	Place	Comments

Week 2

Day	Date	Time	Coach	Comments
6				
7				
8				
9				
10				
Reward week 2				
Follow up		Time	Place	Comments

Week 3

Day	Date	Time	Coach	Comments
11				
12				
13				
14				
15				
Reward week 3				
Follow up		Time	Place	Comments

Week 4

Day	Date	Time	Coach	Comments
16				
17				
18				
19				
20				
Reward week 4				
Follow up		Time	Place	Comments

Week 5

Day	Date	Time	Coach	Comments
21				
22				
23				
24				
25				
Reward week 5				
Follow up		Time	Place	Comments

Recommendations at each follow up.

1. Ask how training is perceived. If the person training finds it demanding, tell them that it is very common. If the results are currently not improving tell them that it is normal and that it is essential that they keep trying.
2. Ask if any obstacles hindering training have arisen (use Appendix 9 if suitable).
3. Praise the trainee for their endurance and for trying their best. Do not emphasize results in the training program.
4. Remind of the next time for follow up.

Examples of questions at follow up

Question	Answer	Comments
Have you been able to train each training day?		
How has training been?		
Have there been any obstacles hindering training?		
Have there been any factors you find affecting training negatively (e.g. noise).		
Have you experienced any changes in everyday life following training? (e.g. more tired, more alert or more focused)		
Is there anything you would like to ask that has not been discussed?		

APPENDIX 12 - EVALUATION

RESPONSIBLE COACH:_____

NAME:_____

PART 1: EVALUATE THE EFFECTS OF TRAINING

1. Decide what the evaluation aims at investigating, i.e. what factors you are interested in assessing. Examples of factors can be “concentration” or “mathematical ability”.
2. Next, we recommend that you choose what tools to use to evaluate each factor. In the “Extra information” section at the back of this book there are examples of how different aspects can be assessed.
3. Decide what persons are to participate in evaluating each factor. To evaluate the factor “concentration” it can, for example, be appropriate for both teachers and parents to complete questionnaires.
4. Decide dates for evaluation assessment point 1 (before training), point 2 (after training) and point 3* (follow up).

Factor	Tool	Participant	Time (assessment point)			Comments
			1	2	3*	

** A third assessment is not mandatory.*

PART 2: EVALUATE THE EXPERIENCE OF TRAINING

Below are questions that you can ask to evaluate the experience of training. You may add your own questions.		
Question	Answer	Reflections
What have you perceived as good with training?		
What have you perceived as bad with training?		
Was there anything that hindered you from performing your best while training?		
Have you experienced any changes at work following training?		
Have you experienced any changes at home following training?		
Your own questions	Answer	Reflections

APPENDIX 13 – RATING SCALES AND NEUROPSYCHOLOGICAL TESTS

Below are presented examples of how various factors can be evaluated using standardized questionnaires and neuropsychological tests. This is intended as an aid for those who are certified psychologists and are planning to conduct an evaluation. Note that these are examples and not a comprehensive description.

RATING SCALES	AREA	AGE	INFORMATION
SNAP-IV, Behavioural rating scale for children	Inattention and impulsivity (ADHD symptoms)	5 – 11	www.adhd.net
"Behaviour Rating Inventory of Executive Function" (BRIEF)	Executive functions	5 – 18	www.mhs.com
ASRS, Adult-ADHD Self report scale	ADHD symptoms	18 – and older	http://www.psychiatrictimes.com/clinical-scales/adhd/
Brown ADD scales for children and adults	ADHD symptoms	3-12 and 12-adult	http://www.drthomasebrown.com/assess_tools/index.html
TESTS	**AREA**	**AGE**	**INFORMATION**
"Conners' Continuous Performance Test"	Attention and executive functions	6 – and older	www.pearsonassessment.com
Subtests: digit span and letter-number sequencing from "Wechslers Intelligence Scale for Children" – fourth edition	Working memory	6 - 16	www.pearsonassessment.com
Subtests: arithmetic, letter-number sequencing and digit span from "Wechslers Adult Intelligence Scale" – fourth edition	Working memory	16 – and older	www.pearsonassessment.com
Ravens coloured matrices	Problem-solving (non-verbal)	4 – 11	www.pearsonassessment.com