What is dyscalculia?

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Test – Dyscalculia – Dr B Adler

Mathematics Screening

INTRODUCTION

A Book addressing Difficulties in Mathematics

This is a book about mathematics; understanding what mathematics is really about. Mathematics cannot be separated from the particular cognitive processes in operation whenever we apply our minds to a mathematical task. My aim in this book is to examine and illustrate the most common reasons that people have mathematical difficulties.

Many people have mixed feelings about mathematics, even those who did well in it at school. Very often the cause of these feelings is the way the subject is taught: it usually isn't presented in an inspiring or exciting way. Many students feel that mathematics is boring, and can't see its relevance to everyday life. Such experiences are unfortunate and misleading. Mathematics is an important part of life. It is impossible to ignore it, because situations arise nearly every moment in our day to day life which require us to make calculations, systematize information and make decisions. This is what mathematics is really about.

There is no other school subject to which we lend so much weight as mathematics. Even if a student performs well in other subjects and is generally successful, with many friends and good family relationships, they are often likely to be insecure about mathematics. Students commonly question their own mathematical ability: *"Why can't I do this math's? Why am I not as good as my friends? Maybe I'm just really stupid!"*

Even if these questions are not spoken aloud they are formed in the mind of students who experiences mathematical difficulties. The experience is devastating for the self esteem and if it continues unchecked, can eventually impact upon the entire experience of childhood. It can destroy a child's school years and lead to the later development of psychiatric symptoms.

In my field I meet many children and youngsters with their self esteem shattered because of their mathematical failures. It really isn't strange: who can handle failure after failure every day and still keep up their self confidence? The feeling of being a failure and being different to everyone else is extremely common in people who repeatedly experience failure without ever having the opportunity to overcome it. In school, almost every day in is filled with moments in which students must use their mathematical thinking. When you see it this way, it is not very strange that many students give up altogether and refuse to work with mathematics at all. Often older students start to play truant from classes. They stop doing their homework and do everything they can to thwart the well-meaning efforts of their parents. All of this is an understandable human reaction to repeated failure and shattering of one's self-esteem. We simply decide that enough is enough: "*I cannot handle anymore!*"

Many people with mathematical difficulties can testify how misunderstood and different they have felt during all their years in school. But I also meet some people who, in their adulthood, have refused to let their failure beat them. They start studying mathematics again and prove, not least to themselves, that they actually are not stupid. Many of them succeed! They win back their self-esteem, and many experience for the first time inspiration and enthusiasm for the subject. They find themselves thinking: *"Math's isn't too bad after all! It's actually fun! Now I finally understand the use of mathematics."*

This book addresses important issues concerning dyscalculia, and it has been my aim to present what we in the field now know about the subject in a clear, understandable way. The following chapters look at reasons for dyscalculia, diagnosis, and above all, how to provide the right kind of help. But before I begin my examination of dyscalculia, I want to first say something about what mathematics is really about.

HOW DOES MATHEMATICAL ABILITY DEVELOP?

All human knowledge, particularly of a logical and mathematical character, originates in our interaction with the environment. The interaction begins long before enrolment in school. It basically begins at birth, or one can say even earlier. Even when only a few days old, the infant can distinguish between two objects and one, even if unable to express this in words. *Understanding of numbers*, such as comprehending how many objects one sees in front of one, is an important element in mathematics, an element present in rudimentary form already at birth.

At the moment of birth a sorting process begins through which the child, on the basis of *categories* and *prototypes*, makes the world more understandable, bringing order out of chaos. These efforts to create order and gain understanding involve the creating of relationships, the development of feelings, and the use and presence of objects of many kinds. In a multitude of encounters with others, the child learns to distinguish between the joy and distress of other persons. Being confronted with the joy of the parents and of many other persons, for example, leads to the child's acquiring a prototype or a general picture of how joy tends to be expressed and can be recognised. This is true just as well for feelings of sorrow, dejection, grief, and dissatisfaction, as well as feelings of many other types. These *prototypes* become increasingly differentiated during a person's lifetime so that one becomes able to gradually distinguish, for example, between different types of distress. In ways such as this, subcategories are created, subordinate to main categories. Categories and subcategories are formed both for feelings and for concrete objects. The infant investigates many things by use of its body. It grabs hold of things, tastes things and hugs other persons. Things also are given names. In the beginning ”mamma” refers both to the mother and to all persons who are similar to her. Later the concept of ”mamma” becomes unique and denotes only the child's own mother. The child also meets other women referred to as ”mamma” but sees these as being mothers of other children. In this process of increasing knowledge, the child begins with general categories but becomes increasingly able to specify subcategories. At the beginning, vehicles of all kinds may all be referred to as ”car” and all pieces of furniture the child sits on as ”chair,” but these categories are gradually divided up into those of truck and car, of red car and yellow car, and of sofa and chair. In its search for both main categories and subordinate ones, the child may first group in terms of cars being one category and trees another, but soon groups these in terms of *size*, *colour*, *form* and whatever.

At the age of about 1½ years, the child gains insight into the fact that objects exist even if the child is unable to see them. O*bjects* having become *constant* now, the child is able to thinks and talk about them even if they cannot be seen at the moment. This is the first step toward being able, by about the age of starting school, to replace concrete objects by numbers. The number ”2,” for example, can replace two apples the child is unable to see but thinks about.

From 1½–2 years of age, the child begins to have a genuine understanding of there being objects that have certain characteristics in common quite apart from colour, form and size, for example. A ”car”, a ”bed” and a ”glass” each has special characteristics of its own. In a playful way, the child practices applying the knowledge it has just gained, systematizing everything it imagines or encounters in terms of the categories it has learned. The child also uses ”what” and ”why” questions to increase its knowledge of the world.

It is first at the age of 3–4 years that the child is able to determine numerical quantities of varying size. The child ”sees” whether there are 2 toy cars or 3 lying on the table. The child begins to *count*. Initially, counting has more of a chance character. In counting what are in fact four things, the child may count ”one, two, five, ten” The child soon learns the correct sequence, however, and then counts ”one, two, three, four”. Yet considerable time ensues before the child begins to understand that the number ”4” is to be equated with there being four objects. If one shows a child the five fingers on one’s hand during this period, it is able to count them one to five but still has difficulties in generalising this. If one shows the child one’s other hand, the child again begins again to count them, ”one, two, three, four, five”. It is first at the age of five or so that child is able to say how many fingers there are on a hand without using the strategy of counting them.

During the pre-school years, an understanding of certain more complex concepts is attained, such as of what is meant by *opposite*. Already at the age of 2½–3, the child can distinguish two objects as being ”little” and ”big,” provided the difference between them is sufficient. Insight into the distinction between ”long” and ”short” and between ”high” and ”low,” however, is not achieved before about the age of 6–7 years. An understanding of which of two numbers, such as *17* and *19*, is larger than the other is not achieved before about another year.

The examples just given illustrate certain important functions that form the basis for the child’s mathematical abilities both before and at the time of entering school. It is important then that the skills that the child has learned become *automized* so that the child has no need of pondering, for example, over the question of how *9* and *6* are to be read or be written. The child needs to be able to invest its energy and thought into mathematics as such, without having to wonder about what form individual numbers take.

We often expect that by the age of seven or so children can begin to work with numbers. Nevertheless, many children of this age are still unable to do so. They can learn perfectly well to recognize and write individual digits and can learn simple computations such as *2 + 3 = 5* or even *12 – 3 = 9*, but they do not yet have a deeper understanding of what numbers really are or how the number series is built up. Insight into the fact that it represents a system in which each number is separated from the adjacent number by 1 first develops about a year later. Thus, early arithmetic training traditionally deals with getting the child to remember that *2 + 3* is *5* and the like. If a child is readily able to learn and remember such things, simple arithmetic is no serious problem.

When entering school or shortly thereafter, many children are able to count from 0 to 100 or even beyond. This does not necessarily mean, however, that they have an adequate *understanding* of numbers. A child may easily be able to *count* without having any deeper understanding of the fact that each number can be seen as representing a particular *quantity*, for example that the number ”12” can be divided up in such ways as that *6+6=12* or that *12=11+1*, at the same time as it is the 12th number in the number series. Those children who have not yet understood the deeper meaning of numbers in this sense can nevertheless perform simple arithmetic calculations, but do it more mechanically. They simply learn that *6+6* is always *12*. The math that is taught could be said to deal more with remembering than with mathematics as such. A child may have considerable difficulties when faced with mathematical tasks that are decidedly more complex. If the child’s progress in math is held up at this point, this can result in severe disappointment both for the child and for its parents.

Counting provides a help for the child in remembering where in the number series various numbers are located. This can also help the child determine, for example, which of the two numbers ”17” and ”14” is the larger of the two. This provides no automatic understanding, however, of the relationship between a *number* and the *quantity* it also represents, such that the number ”125,” for example, can be seen as consisting of 125 different parts, each with the size of *1.* Being able to count is also not necessarily coupled with insight into the *number system’s* being so constructed that each number is separated from the next by a distance of *1 (one)*. Insight into this is not achieved before the age of 9–10 years.

The fact that five ants are more than four elephants, despite elephants being much larger than ants is the sort of thing that an *understanding of numbers* deals with in part at this stage.. In the early school years a child can continue confusing questions of the number and the size of objects. The child can believe that *20* coins are greater in number when spread out over a tabletop than when gathered in a pile. This reflects a lack of insight into the principle of *number constancy*, i.e. that *20* coins are the same in number regardless of how they are grouped, and similarly that the size of the coins has no effect on how many they are.

Since numbers can serve as symbols of concrete things, they gradually replace the things themselves in the child’s mathematical thinking. At 10–12 years of age, a child who already knows that the number ”35” consists of *35* parts may begin dividing it into *7* parts of *5* each, and into *5* parts of *7* each, ”discovering” multiplication and division in this way. Before this can lead much further, however, the child needs to have a clear conception of how numbers represent symbols of concrete things.

During this period, math begins getting a face-lift for the child, who becomes increasingly aware of math dealing with more than simply adding, subtracting, multiplying and dividing and gaining somewhat more of the visual character typical of ”higher” mathematics. The tasks the child is given are more frequently concerned now with the reading off of figures from tables and diagrams and with problems of volume or area. The four types of arithmetic operations are seen increasingly as simply a means of solving mathematical tasks, emphasis being placed increasingly on being able to visualize things and obtain an overall view of a problem, and being conscious of the structure of things. In doing math assignments, the child is increasingly expected to find its own solutions to problems and to search in the books available for the principles or methods needed to complete a task. This calls for both *problem-solving ability* and *ability to plan.*

HOW DO WE RECOGNIZE DYSCALCULIA?

In my contact with children and youngsters who have difficulties with math's, I am most often struck by the great frustration that they and their friends and family experience. Rapid swings between hope and despair are a common experience. One moment the student can handle a particular task, but a moment later, or the following day, they may fail with the exact same task. On the one hand the student may be a high achiever with a quick mind, while on the other they may be stumped at any moment by a simple counting problem such as 5+4, for which they must count on their fingers.

Many parents of these students have spent countless evenings tutoring their children in basic mathematics such as the multiplication tables. The knowledge seems to be there, but the next day when the child goes off to school, it is completely gone! It is then understandable that parents may begin to believe that their child simply does not want to learn. It is not unusual for parents to wonder: *"Is she playing games with me? Why else would her results be so uneven? Everyone else seems to think she is as smart as all her friends…"*

It is very common for people surrounding the student with dyscalculia to experience a strong sense of powerlessness. The student's performance in school can vary dramatically, climbing to heights but then dropping swiftly again like a roller coaster. One moment the student has the knowledge and ability to perform a task, and the next moment everything is gone, only to re-appear again a couple of days later as accessible knowledge again. In other cases the student cannot remember at all. Initially this might seem to be a memory problem, but the information is in fact stored in the long-term memory. The student in this case has problems automatically retrieving the information when it is needed. They have to concentrate extremely hard to access stored information such as the multiplication tables. It is therefore understandable that many children with this type of difficulty get tired of doing math's, and eventually give up on mathematics altogether.

At this point I want to clearly state that dyscalculia indicates *specific or special learning difficulties in mathematics.* Students with specific difficulties do not have problems with all mathematics. Usually, though, their ability across the whole subject suffers, and it is very common for the student suffering from dyscalculia to gradually build a picture of themselves as "stupid", because they are not as successful in mathematics as their friends.

Students with specific learning difficulties in mathematics obviously differ from those who display more general learning difficulties. This latter usually performs more evenly over time. They perform at the same level whether it is Monday or Thursday in the school week. Their difficulties are characterized mainly by their need of extra time in the learning process. The use of simplified learning materials may be necessary. However, this is not always the case with those who display specific learning difficulties with mathematics. Their difficulties are characterized by uneven performance: sometimes they exceed all expectation and perform brilliantly, but then a moment later drop to a very basic level where they need to count on their fingers to handle the most simple counting problem.

People with dyscalculia generally have normal intellectual capabilities, but have problems with certain thought processes (cognitive processes). They have difficulties with certain types of thinking. This is especially noticeable in the subject of mathematics, but is also evident in both everyday situations and other school subjects.

It is common for these difficulties to first appear in problems with telling the time (with analog clocks), problems with temporal orientation (knowing what time it is), and problems with planning and remembering to keep appointments. The nature and severity of the problems may vary from child to child, but it is possible to identify whether or not they suffer the *specific* forms of difficulties typical of dyscalculia.

How do the Difficulties begin?

Before starting school most children have an expectant and positive attitude to counting. The beginning of school means to most children that they are going to be taught how to read and count. For most students this proceeds in a relatively simple and uncomplicated way. They learn both to read and to count by whatever teaching methods are in use. Some children, however, develop counting problems right from the start. They may have difficulties in writing down the numbers, or with understanding that each number represents a fixed amount, e.g. that the number “4” represents four units. They may have problems with number order, and then run into difficulties with fast calculations, which require knowing, for instance, that “10” is two more than “8”. For these children all calculations are made with great difficulty. They simply do not get a “flow”, and every calculation takes an enormous amount of effort. In this case, a lot of short breaks are needed during the school day. If the student does not get these short breathing-spaces to rest their mind for a moment, they usually provide pauses for themselves by thinking about other things or walking around the classroom.

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Before school has even started, many children already have clear ideas about what will be easy or difficult. During pre-school children are prepared for counting and writing, and those children that have problems early on soon begin to avoid counting and writing. They sense their own difficulty and create a kind of resistance or emotional blocking. Unfortunately, such blockings create serious obstacles to the learning process once school starts, and they might affect the child's attitude to schoolwork throughout their school career.

When a teacher identifies a child's difficulties in counting, once school has started, the child is usually offered help. The help may be specialized help from an informed psychologist or teacher, and it may be offered separately, in a group or in a class.

When mathematical difficulties are discovered, rigorous practice in the problem areas generally commences, both in school as well as at home. It is not rare that the student practices the problem areas several hours a day, during the daytime in school and in evenings at home. This practice is well-intentioned. However, the problem becomes more and more obvious after several years' practice without any discernable development in mathematical ability. After years of hard work, the child begins to lose her motivation. She simply refuses to do anything that has to do with mathematics once she discovers how minimal her progress is considering all the years of hard work. It is not uncommon for the gap between such students' abilities and those of other children of the same age to increase rather than decrease, despite the long hours of practice.

What begins as difficulties with quickly and easily remembering and writing down numbers often develops during school years into a general problem with the whole of mathematics. Knowledge-gaps arise because the student eventually refuses to work with anything that has to do with the math's, because of their continual experience of disastrous failure. This usually leads to poor self esteem, with verbalized thoughts about being stupid or different and perhaps even non-verbalized thoughts about not wanting to live anymore. If this seems like too strong a reaction, we must consider that it has been proceeded by years of daily failure and frustration. In this situation it is easy for children to acquire a picture of themselves as being worthless, and to begin to wish that they could simply disappear.

The strong reactions described usually occur when the child reaches adolescence. At this age, the child often rebels against all help from teachers, student assistants and parents. He longs to be able to manage on his own without any help. This in itself is a healthy and normal wish for a child in the process of developing into an independent adult.

Initial specific difficulties in mathematics often develop into more general learning problems by the end of primary school. The reason for this is that the student sets up emotional blockings for herself at the same time as she suffers from increasing knowledge-gaps. By adolescence it can therefore be hard to discover whether a student has more general or specific difficulties. The answer lies in the child's personal school history.

I have here been describing an example of a course of events at its worst. Unfortunately, it is a quite common story. I am mentioning it to thereby point out the need of initial assessments, but also the importance of correct help. It is crucial to understand what the student should avoid to practice and what they really need to practice more, in order to ensure progress. It is success during practice that creates motivation. It generates the desire to learn more in the subject.

Some children have problems with early mathematics. They can have problems with the 4 basic calculations: addition, subtraction, multiplication and division. Others first develop problems at the age of 10-12 when the mathematics partly changes form and becomes more visual. On the other hand, some of the children that had problems with early mathematics might blossom later, becoming much more successful when they begin to work with higher and more visual mathematics. This is providing they are given opportunities to work with higher mathematics and not only practice tasks of a basic level with which they have difficulties.

Dyscalculia and other Mathematical Learning Difficulties

The name "Dyscalculia" is a contemporary derivative of the latin "dys", which means a form of special difficulties – not inabilities! - and the greek "calculus". Freely interpreted this word means "counting-stone". Out of this combination, "dyscalculia" was created, to refer to difficulties with counting.

Dyscalculia is characterized by specific difficulties with certain types of mathematics, and this is what differentiates it from other mathematical learning difficulties. If a child has problems with the four basic types of calculation, this will indirectly affect their ability in higher mathematics. If there are difficulties in understanding basic numerical facts, then it follows that more complex calculations will also be affected. It simply takes the person with dyscalculia a much longer time to complete different mathematical tasks. It is important to remember that many people with dyscalculia are able to solve complex tasks in mathematics, but they usually have difficulties in solving the task fast. This indicates the importance of giving students with dyscalculia tasks at the right level. Practice at too low a level can be degrading and disheartening, and can diminish motivation. It can rather contribute to the child finally giving up altogether, and according to my experience this is an all too common course of events.

I think it is meaningful to talk about at least four different forms of difficulties in mathematics:

- Acalculia
- Dyscalculia
- General difficulties in mathematics
- Pseudo-dyscalculia

Different mathematical learning difficulties have different cognitive and psychological causes, and these each require different remedial work. For this reason, differential diagnosis, as used in medical health care, is particularly valuable. Students have different kinds of difficulties and therefore need different kinds of help. It is entirely possible that the ability of a student with dyscalculia will get worse with too much practice in the wrong areas. Likewise, children with acalculia will certainly fail if they are taught mathematics according to traditional methods.

In cases of acalculia, the student displays a total inability to carry out any mathematical tasks at all. The total inability to count usually indicates brain damage. The problem is apparent when the child, even despite intense practice, is unable to learn the basic principles of counting. This may be evident in the inability to learn the order of numbers 1-10 or to carry out simple additions such as 4 + 2 = 6. The group of people with acalculia constitutes less than one percent of the population.

The diagnosis *dyscalculia* is comprised of a group of related and highly specific mathematical learning difficulties. Dyscalculia is the mathematical correspondent of the reading and writing difficulty *dyslexia*. Most children with dyscalculia suffer from a pure form, where reading ability and ability to understand text is not at all affected. About 20-30% of people with dyscalculia have a mixed form in which they might display problems with both reading *and* counting. These children are unable to attain fluency in reading, and cannot recall numerical facts quickly during calculations. Simple tasks take them a lot of time, and often they have to count on their fingers far into their school years. This kind of learning difficulty is called *automatisation-difficulty.*

Children with dyscalculia usually have normal intellectual capabilities, but often display spectacularly uneven results in intelligence tests. The causes of these difficulties are not emotional or psychological, but can be traced to problems with certain special thought (cognitive) processes.

I have mentioned automatisation-difficulties as an important causal factor of dyscalculia. Another can be *language difficulties*. This is shown by problems with understanding mathematical concepts. A seemingly talented student may be incapable of understanding the general concepts of numbers and mathematical relations, or the written representation of these in mathematic symbols.

A third variation of dyscalculia involves *difficulties in planning,* which surface during the carrying out of calculations. The student with this type of dyscalculia has problems in following their own line of thought when solving a mathematical task. The student gets easily lost, or stuck on a non-functional sequence. It is not unusual for them to suddenly lose the thread of a good strategy and find themselves sitting inactively. Problems with *visual perception* can also lead to problems with logical ability, and can affect counting as well. This type of difficulty we often see in children who have problems learning to read the ordinary analog clock, with hands.

A child with *general learning difficulties in mathematics* displays general problems with all learning, not only mathematics. As a rule these children take a longer time than normal with all learning. Usually the child benefits most from working at a slower pace and with simplified teaching material. In intelligence tests, children with more general difficulties usually perform below average, but with a quite even result. In other words, these children are even in their difficulties, from one subject to another, and also from one day to another. Children with more general difficulties usually do not experience as much frustration in their learning environment as those with dyscalculia. There is a general agreement that they simply need more time to learn things.

Pseudo-dyscalculia is a big and important group in which learning difficulties arise from emotional blockings. Children with pseudo-dyscalculia have the cognitive ability to succeed in mathematics, but despite this, they run into problems. They may have committed themselves to the idea that they absolutely cannot be successful in the subject. This thought can be deeply rooted, and perhaps linked to ideas that they are not smart enough. All personal failures in mathematics confirm this view for these students.

In these cases, the nature of the difficulties may be very similar to dyscalculia. However, students with pseudo-dyscalculia are not primarily benefited by special classes or remedial work. Instead the best help for these students might be private talks with the teacher, or in tougher cases with the school psychologist, where emotional blockings can be faced and overcome.

Girls form an overwhelming majority of the students with pseudo-dyscalculia. Despite having average intelligence, this group nonetheless has severe difficulties with mathematics. Because the percentage of girls is so large, I personally believe that teachers should consider teaching girls and boys separately in this subject. It has been proven that girls have increased self-confidence when there are no boys in the classroom, and there is no risk of negative comments from the boys, which unfortunately is the common occurrence.

Sometimes the cause of emotional blockings can have its origin in past failures that the student gradually becomes afraid of repeating. It becomes convenient for the student to explain these failures to themselves in terms of not being smart enough, and gradually they start avoiding everything to do with mathematics.

Pedagogical Signs

How then do we recognize dyscalculia in everyday life? In mathematics? In the child's day to day life? Below I present a simple check-list of problems that might be indications of dyscalculia. To determine conclusively whether a child really suffers from dyscalculia, a thorough assessment in collaboration with an informed psychologist or doctor is necessary.

The following list should not be seen as a complete analysis, but it contains examples that are common when the specific mathematical difficulties that characterize dyscalculia are present. You can most often recognize some of the signs the person with dyscalculia might have. However, if a person displays problems relating to most of the points in the checklist this indicates that their difficulties are general mathematical; difficulties, and *not* dyscalculia.

Difficulties with reading and comprehension:

- Mixing up similar-looking numbers in reading e.g. ***6*** and ***9*** or ***3*** and ***8***.
- Inability to comprehend the space between numbers, so that for instance ***9 17*** is read as ***nine hundred and seventeen***.
- Difficulty in recognizing and therefore using calculation symbols i.e. plus, minus, multiplication and division symbols.
- Difficulty with reading numbers containing more than one digit. Numbers with zeroes can be especially difficult, e.g. ***1004*** or ***7069.***
- Confusion of reading direction, i.e. reading numbers in such a way that ***12*** becomes ***21***. It is not unusual for some children to shift the direction of reading so that some numbers are read accurately, from left to right, while others are read back to front.
- Problems reading maps, diagrams or tables.

Difficulties with writing:

- Written symbols, often numbers, are reversed or rotated.

- Problems copying numbers, calculations or geometric figures from a set picture.

- Problems recalling numbers, calculations and geometric shapes from memory.

- Difficulties remembering how numbers and calculations are written. In this case it can be easier for the student to spell the number with letters.

- Difficulties remembering how mathematic symbols are written, e.g. "+" or "–".

- Inability to correctly write down numbers containing more than one digit. Just as with reading problems, it might occur that zeroes are lost, e.g. that ***one thousand and seven*** is written as ***107***, or that ***seventeen*** is written down with the seven first as ***71***, or that ***four thousand five hundred and thirty five*** is written as four separate numbers: ***4000, 500, 30, 5***, i.e. the number has been divided into divided into its component parts.

Problems with understanding concepts and symbols:

- Difficulties understanding mathematical symbols, e.g. difficulty remembering how the minus ("-") should be used.

- Problems with understanding the concepts of weight, space, direction and time.

- Problems with understanding and answering oral or written problems that are presented with words or in a text or picture.

- Difficulties understanding concepts of numbers as much, more most or quantity measures.

- Problems with understanding the concept of 'amount', where numbers are used in conjunction with units to signify amounts in measurements, e.g. ***100 meters***. Problems can also arise in understanding ordinal numbers, that is, understanding and stating a numeral's place in a sequence, e.g. first, third, seventh. Finally, there may be problems with understanding the relations between units of measurement, e.g. centimeters to meters to kilometers.

- Problems with the practical application of mathematics, for instance: Ann's house is 1 km from her school. Linn lives twice as far away. What distance does Linn have to travel to get to school?

Problems with number sequence and mathematical facts:

- Difficulties with arranging numbers by size. Also problems with number positions, e.g. whether 16 comes before or after 17.

- Problems with number sequence, so that the child can not automatically understand that ***74*** is five more that ***69***, or is unable to place the numbers 8 or 27 in a numerical series. These children need to count on their fingers to manage basic calculation.

- Bad memory of simple numerical facts, e.g. the multiplication tables.

- Difficulties doing mental calculations, due to memory problems which causes the student to "lose" the relevant numbers being used in the calculation.

- Problems with counting backwards, e.g. ***four short of 100***.

- Taking a long time to solve simple mathematical tasks, even though they are written down.

Problems with complex thinking and flexibility:

- Rigidity in thinking, shown by the inability to choose the right strategy in problem-solving, and having difficulty changing strategy if the chosen one does not work.

- Problems following the different steps in a mathematical task.

- Problems making reasonable judgments, e.g. estimating measurements to make rough calculations, and arriving at reasonable answers.

- Difficulty with following one train of thought when solving mathematical problems, including the inability to stick to strategies that work.

- Difficulties with planning, i.e. problems with planning how to proceed in a task before it is actually attempted.

- Problems in shifting from a concrete level to more abstract thinking. This is shown in difficulties in switching from concrete objects to mathematical symbols.

This can also relate to an inability to understand mathematical concepts and relations and to do mental calculations. The symbols lack meaning for the child. They can read them, but they do not understand the meaning of them.

The criteria presented here should be used with great care. This check-list is not intended to provide the basis of a careful and comprehensive assessment of a student's difficulties. It is most important to first examine and discover the causes of the child's difficulties, and then to apply the appropriate remedial method.

Let me give an example:

Lisa does not have many difficulties with basic mathematics. She is quite good at division and multiplication. Despite this, however, she has difficulties with solving written math's problems. In this she often fails. An examination of her general reading and comprehension ability shows that she has at least average performance in both reading and writing. A closer analysis of her problem shows clearly that Lisa has difficulties with identifying essential facts in the text. She is simply unsure of which numbers are relevant to the mathematical task. She is even unsure of which type of calculation is required. Is it addition or subtraction? It is apparent that Lisa's main difficulty is with planning, and that she needs help to find good strategies to handle mathematical tasks. She needs practice in planning to solve mathematical tasks step by step in a continuous sequence.

If an uninformed teacher, parent, or psychologist had focused on Lisa's symptom, difficulties with written mathematical tasks, they probably would have assigned her remedial reading work. However, a closer analysis reveals that her problem is not at all related to primary reading difficulties, and this understanding demands a different focus for remedial work.

Characteristics of Dyscalculia in every day life

In day to day life it is common for a competent child to surprise us by running into sudden difficulties with mathematics.

It is common for the person with dyscalculia to have had (or have) problems with learning how to tell the time. It may be that they have eventually learned to, but the skill took them a long time to acquire.

To one who knows how to read the time, it may seem simple to read a normal analog clock. But this skill puts demands on many different cognitive functions. First we have to read the angle and direction of the hands. Then we have to calculate what the actual time is. The clock does not actually show us that it is *twenty to two* in the afternoon. Or that it is *five past nine* in the morning. It merely provides signs that enable us to calculate this.

The reading of an analog clock (with hands) puts demands on our visual perception, working memory and understanding of the language.

To many people with dyscalculia it can be considerably easier to read a digital clock, where the time is told by simply reading the numbers in one sequence from left to right, e.g. *01:40 pm*. The digital clock does not show that the time is *twenty to two*. This calculation also we have to do by ourselves.

It is not only telling the time that many people with dyscalculia have problems with during their adolescence. Many also have difficulty with temporal orientation (knowing what time it is). This can express itself as a problem with estimating how long an hour or 24 hours is. In this case, planning ability is invariably affected and indirectly so too are all activities the student pursues. Difficulties with temporal orientation often involve with understanding the time sequence of a course of events.

We are not born with an in-built conception of time. Instead it develops and is maintained through continual practice. In this way we gradually learn, for example, how much we can accomplish in one hour. But the knowledge is never perfected, as for instance when we learn how to swim or ride a bicycle, or even wash the dishes. It has to be continually in use for us to develop good *time-planning ability*.

Difficulties with temporal orientation lead to serious problems when the child is required to plan a homework schedule and other things by herself. This becomes especially clear when the task is not to be completed in one day but for example over two weeks. It is common for students to overestimate the time they have at their disposal, without having dyscalculia. But the person with dyscalculia may have additional difficulty in working out in which order they need to complete the tasks.

However, difficulties in day to day life are not limited to the planning of homework. They are manifest in *all* planning, even in concrete situations such as how the tidying of their bedroom should be planned and carried out. Many children with dyscalculia need a rigid structure in their day to day life. Unfortunately, it is very few of them who ask for help and discipline by themselves.

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The ability to make rational judgments is necessary for all normal everyday activities. It is not limited to use in mathematical calculations. Every day we mentally ask ourselves innumerable questions: What can I reasonably achieve in an hour? When might I reasonably be home again after having played football in the evening? How much food can I reasonably eat, i.e. how much food should I put on my plate?

The ability to make rational judgments is also necessary when we consider human relationships. Judgment is needed to work out how to proceed in a new intimacy, or to think of a good answer when you come home too late in the evening. Rational judgments are based on information gained from previous experience. Using this information imaginatively, we can visualize several different alternatives and solutions and then pick out the one that seems best.

Many people with dyscalculia have problems with handling not only time but also money. If a person has difficulties with understanding numbers in general then it can be difficult to make a good reasonable judgment of monetary value. How can they tell whether one liter of milk should cost 1 dollar or 10 dollars? This problem might stem from the fact that they cannot comprehend which of the numbers 1 or 10 is the biggest and how large the difference is. That is why it may seem reasonable to a person with dyscalculia that the milk costs 10 dollars if someone tells them that it costs that much. In the same way it can seem reasonable to this person that the distance between New York and London is 600 km or even 6000 km.

Many people with dyscalculia suffer from a bad memory. They not only forget what they were going to do, but they also forget agreements they have made with other people. If they are asked to do three things in succession they often only remember the last one mentioned. The other two are forgotten. This explains part of the difficulties these children have in mathematics. On top of this they bear the emotional burdens that arise if they are not getting the right treatment and help. Because of this combination, it is not uncommon for a child to be quiet and well-behaved in school but release all of their frustrations once they are home. Parents and siblings see a totally different child to teachers and school friends. The teachers might describe a student who has many learning difficulties but works diligently and is full of energy. But when the school day is over often the child has run out of energy, and the bad temper and violent mood swings occur. This adds extra strain on the relations at home.

Many parents try to help their children by encouraging them to practice what they find difficult in mathematics. This can have varying success. Frequently parents have a hard time getting their child to work at all. This after-school practice time usually tends to become longer than planned, and the child often develops attitudes and behavior of dislike and avoidance. If they are left alone for a moment with their mathematical tasks, their mind instantly wanders. This home practice is thus very demanding on both parents and children. On top of this, it rarely produces good results.

Over all, the adolescent with dyscalculia is recognizable in that they need a lot of support and help in everyday life. They can have obvious difficulties not only with mathematical calculations, but also when it comes to planning, pursuing hobbies and socializing with friends in spare time. These things can often go wrong for the child, through no intention of their own. It simply seems to happen that way.

How long has Dyscalculia existed?

Difficulties in mathematics have been observed for at least 100 years. The first medical studies published observations about a group of patients with serious neurological brain damage. A german doctor, Henschen diagnosed this group with *acalculia*. This diagnosis primarily resulted from their complete inability to manage the most simple mathematical tasks. This initial group had obvious neurological injuries.

Another german, Gerstman, was the first to use the term *dyscalculia* during the 1940s. He saw a practical value in separating the inability to count from more specific learning difficulties in mathematics. These specific difficulties related only to particular areas of mathematics.

The notion of *developmental dyscalculia* was first put forward by L. Kosc in the 1960s. At the time he was a leading scientist in the United States.

The concept of developmental dyscalculia has two aspects. Partly it identifies mathematical difficulties that do not have a psycho-social explanation, but are genetically determined. In other words the social or family environment does not contribute to the difficulties in counting, which primarily have a biological basis dictating delayed development. The concept also conveys that this type of difficulty is linked to childhood development, and therefore is neither static or permanent. The nature of the problem changes during the child's development. With the right treatment, the right practice and above all with neurobiological maturity, the difficulties gradually lessen.

L Kosc and other mathematical scientists in the field of neurological research were strongly influenced by the neuropsychologist and neurologist Alexander Luria. He expounded a theory that the brain can be divided into three functional blocks which develop and collaborate in a very special way. This theory has become a building block for neuroscience around the world.

According to A Luria's theory, the brain consists of collaborating blocks, where block 1 is a *regulating* block that governs basic functions necessary for survival.

This part is comprised of mainly the brainstem and the middle brain. Block 2 *analyses* incoming information from the surrounding world and consists of mainly the back part of the brain (parietal lobe, occipital lobe and temporal lobe). Block 3 is the ruling block. It is here, in the frontal lobe, that planning is carried out and our actions are governed. The frontal lobes rule our thoughts, and through this rule our behavior.

A Lauria described many different variations of mathematical difficulties. The three most important are:

- Lack of logical understanding.
- Lack of planning ability.
- Inability to manage simple mathematical tasks.

Lacking of logical understanding is usually caused by problems with spatial perception, i.e. problems interpreting visual information. This leads to difficulties with even reading an analog clock. Reading the clock is a several-step process with a tricky but logical form.

Lack of planning ability is obvious in problems with planning and carrying out different mathematical tasks. It is common for the child to "lose" strategies that work well, or to continue to try to apply wrong strategies despite several failures. With lack of planning, he gets easily lost and therefore has difficulties understanding the solutions to tasks.

When there is an *inability to manage simple mathematical tasks,* the child runs into difficulties with even the most simple mathematical tasks such as 2+4. This expresses itself most obviously in the continuing need for the child to count on their fingers throughout their school years.

As recently as the 1990s, Israeli child-neurologists headed by R Shalev developed knowledge about dyscalculia through large-scale studies of children's comparative reading and writing abilities. They did a sex-analysis to determine the proportions of girls to boys and developed a long-term follow-up for children diagnosed with dyscalculia. They posed the important question: *Is it possible to overcome dyscalculia with the right remedial work?* I myself have been carrying out similar studies in Sweden over the last few years, with the objective of determining whether the right remedial work contributes to people with dyscalculia developing their mathematical thinking.

In the medical world, dyscalculia is accepted as a diagnosis in Sweden as well as the rest of the world. Dyscalculia exists, in the beginning of the 21st century, as an established concept, and diagnoses a special form of mathematical difficulties in which an average or talented overall student may still run into difficulties with mathematics.

How many people have Dyscalculia?

In the 1980s N Badian conducted a large study that showed that *6.4 %* of primary school children had problems with counting and other mathematical tasks, while *4.9 %* had problems with reading. The study revealed that the group displaying mathematical difficulties is very large, perhaps even larger than the group with reading difficulties. This is understandable when you consider that mathematical tasks require several separate skills, including reading skills, that must all function together.

In the 1990s R Shalev and V Gross-Tsur headed a large study, with child-neurologists and child-psychologists examining over 3000 school children. This study diagnosed *6.2 %* of the children with dyscalculia. They also show in their study that there are about as many girls as boys with dyscalculia. In other words the proportion of girls to boys is roughly 50/50. Here the percentages diverge from other difficulties like dyslexia and AD/HD where we usually find two thirds to three quarters are boys.

Although there are approximately as many girls as there are boys with dyscalculia, I have found in my own experience that very few are being discovered. Even when they are, they are often treated in a “lump” together with students with other forms of mathematical difficulties.

Today it is common to talk about numbers of children with dyscalculia at around *5-6%*. If we add other types of mathematical problems, in which general difficulties and emotional blockings constitute the two large groups, the numbers leaps to 15-20%! By far the largest group is that of students who have emotional blockings despite average or above-average intelligence.

What is the Value of a Diagnosis?

I believe there is a great urgency to discover dyscalculia early in children. A full diagnosis cannot be made until at the earliest 10-12 years of age, but this should not stop us from discovering early on the particular form of mathematical difficulties the child suffers from.

There is an ongoing debate as to whether the diagnoses of dyslexia, dyscalculia, or ADHD/ADD have any real value. Certain precaution is entitled, because it can be harmful to diagnose all forms of mathematical difficulties as dyscalculia, and likewise all difficulties with concentration as ADHD/ADD. However, doubt should not lead to the refusal to make any specific diagnosis at all. We then run into the obvious risk of not providing relevant help to children who are certainly in need of it.

I could easily illustrate this point by telling the stories of all the misunderstood children and youngsters that I meet as a child psychologist. They have mathematical difficulties, or difficulties with reading, and gradually have acquired a very negative self-image. Their self-esteem and self-confidence is shattered. Some express thoughts of suicide. These children alone should be sufficient reason to justify the need for accurate and specific diagnoses. A good diagnosis affects several individuals and groups positively:

- The child itself
- The parents
- The teachers
- Psychologists and doctors
- Society

It is extremely rare that we meet a young school child requesting their own diagnosis. However, the older they get, as they continue to fail in mathematics, the more they wonder. Above all children ask themselves*: "What is the actual reason for my difficulties in math's? How can I be so good in so many other subjects, and hopeless in mathematics?"* Their situation becomes frustrating and incomprehensible.

A diagnosis allows most older children to understand the reason for their difficulties. This also helps the parents. Most of all, it helps them to help their child in the right way, but also to be able to put demands on the school to provide appropriate remedial resources.

For teachers and school psychologists the diagnosis is valuable because it enables them to plan the right remedial work and avoid areas of unprofitable and frustrating practice. This may well improve the success of lessons. The diagnosis formally states the need of resources, which can support the claims of teachers and principals when they seek resources for the school.

Sometimes teachers express worries about a diagnosis. They are afraid that the child is going to relax with the diagnosis and stop trying to actively work with mathematics, thinking: "*Well, I have dyscalculia! Then I can't do math's anyway!"* The doubts usually disperse once the teacher starts a dialogue with the child and their parents. In a good dialogue, the child's difficulties are made obvious, but so too are possible ways to work with mathematics. It is just this pointing out of possibilities that makes assessments well-founded. They should provide an in-built guarantee that the child will receive proper treatment. At the same time we eliminate the risk that she will develop psychiatric symptoms like depression and suicidal thoughts. This in itself is a value to psychologists and doctors, not least in psychiatric health care.

A diagnosis is of great importance to both schools and society in general when we plan both remedial work and goals and achievements. Decision-makers and community managers need to know how large the group of people with dyscalculia is. This knowledge is currently very deficient. What you do know, as a decision-maker or planner, is that very many students are failing in mathematics, a much larger proportion than those who have difficulties with languages. This calls for close examination.

If we are reluctant to make a diagnosis then we may prevent children from getting the right help. It may be that we don't want to "stamp" the child with a diagnosis from which it can be difficult to escape. Ultimately, however, this benevolence can lead to misunderstanding, inappropriate 'help', and years of failure, to no end.

In today's health care system, diagnosis is essential. Diagnoses inform the direction of the treatment, and are rarely questioned. While this attitude is seeping into the field of education, a common acceptance of the value of diagnoses is yet to be achieved.

A good diagnosis consists of a summarized description of the individual's difficulties. From this summary one can draw conclusions about the nature of the best possible remedial support. The method of diagnosing a condition in order to specialize treatment uses comparisons with previously observed cases to determine treatments that have been successful in similar cases.

Many people with dyscalculia struggle with their difficulties for years before they undergo a proper assessment, and possibly receive a diagnosis. In my experience, it usually puts the student at considerable ease when someone finally identifies the problems they have been having for so long. Their diagnosis doesn't cause them to give up. Just the opposite! They are suddenly inspired to start working with mathematics in a new way. And the fantastic thing is that they now, as adults, can feel that they can actually succeed. What an incredible feeling!

We humans have a tendency to let our imagination blow things out of proportion whenever we have a difficulty. We usually think the worst. This is no less true when some of us encounter difficulties in mathematics. We tend to think that we are stupid, untalented, lazy, unfocused and totally hopeless. However, understandable reasons for our failure have the ability to overcome these negative thoughts. All of a sudden the child does not need to spend so much energy thinking about why they are so stupid in mathematics. This energy can instead be used to work with the mathematics in a successful way. In this search for understanding the cause of the child's difficulty, a diagnosis can be very valuable.

I mentioned before that a final diagnosis cannot be made before the child is about 10-12 years of age, the same as for dyslexia. However, this should not stop us from beginning appropriate remedial work before this! Above all we have to learn to communicate openly with the child about their difficulties and experiences. The problems they report may not be the same as your own perceptions of their problems. Although we cannot be certain about the exact nature of their difficulties, it is necessary to commence remedial work immediately. If we wait until the child is old enough for a proper diagnosis, we may have wasted precious time and caused the child many unnecessary years of struggle and failure. Specific learning difficulties in mathematics rarely cure themselves. Help is needed.

What is the Difference between Dyscalculia and Dyslexia?

Many people ask me: "*Where do you draw the line between dyscalculia and other types of difficulties with mathematics? What is the difference between dyscalculia and dyslexia? Can you have both? Is there a mixed form? In that case, what is this called? Is it called dyscalculia* ***and*** *dyslexia?"*

These questions illustrate thoughts that frequently arise when people first encounter the term dyscalculia and need to define it in relation to other diagnosis groups. I will expand on this subject later in the book (see the heading "The Investigation of Dyscalculia"), but I now want to highlight a few similarities and differences between the two largest diagnosis groups, *dyscalculia* and *dyslexia*.

A simple definition primarily identifies dyslexia with difficulties in reading written text fast and fluently. Dyscalculia, on the other hand, refers to difficulties with handling and carrying out specific mathematical tasks. Here the differences are very obvious. However, there are also some points of overlap.

There is a variant of dyscalculia that could be called *dyslexic dyscalculia*. This problem manifests primarily in reading difficulties which then lead to mathematical problems for the child. These can be problems with reading numerical symbols and configurations in written tasks or difficulties with reading multi-digit numerals, so that 12 becomes 21. With an error like this in the reading of the task, then obviously the solution will be incorrect, even if the calculations are accurate.

There are in fact several similarities between difficulties with reading and counting. One of the more significant, and most disabling, is the previously mentioned *automatisation-difficulty.* This can be recognized in the lack of "flow" or fluency in reading words such as *and, that, to,* and *as* may not be "automatic", hindering the fluency of reading. Difficulties that correspond to this in mathematics concern the ability to quickly retrieve numerical facts such as the multiplication tables from the memory.

There are several other indirect similarities between difficulties with reading and mathematics. A poor *working memory* is one of the more obvious. In reading, the problem can be recognized when a child reads slowly but steadily, but then cannot remember the word or the text they just read. The professional term for this inability to recall the beginning of a task while you are completing the end of it is called the *phonological loop.* Mathematical problems caused by working memory are evident in tasks that must be solved mentally, in the head. The student may run into great difficulties keeping different numbers in the memory while he is doing the calculation. In other cases, the student may have problems remembering longer instructions or commands. Maybe she will only remember a part of what was supposed to be done. The rest is forgotten, because the information was never stored in the memory.

The Israeli child neurologist R Shalev has shown in his studies that about 17% of people with dyscalculia also have dyslexia. My own research indicates that the number might be a little bit larger, maybe even up to around 30%. However, even if the percentage is this high, it is still the case that most people with dyscalculia display only mathematical difficulties. They have a highly specific form of learning difficulty, and many are very good in reading and languages.

The occurrence of *both* dyscalculia and dyslexia at the same time is nowadays diagnosed as *ICD – 10*, or *mixed learning disturbance*. ICD – 10 is a diagnosis system that is used in the medical field. It is defined by the United Nations and the World Health Organization, and today is globally applied.

In the more pure forms of dyscalculia, common difficulties include problems with number order i.e. being unable to quickly work out which of two numbers is the biggest. Difficulties can also involve the understanding and use of mathematical concepts. A large proportion of people with dyscalculia display problems with following several-step calculations to reach a correct solution. They easily lose their strategy, and therefore run into problems with more complex mathematics. People with dyscalculia often have difficulties in making reasonable estimations and lack an adequate capacity for rational judgment.

Many students with dyscalculia are able to complete mathematical tasks, but within a longer than average time frame. They are unable to retrieve numerical facts from their memory fast enough and must expend a lot of energy doing so.

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Can Dyscalculia be Cured?

Parents as well as teachers have important questions about dyscalculia. Frequently asked questions include:

- What kind of difficulties does dyscalculia refer to?
- Have we done something wrong?
- What kind of help is needed?
- Can dyscalculia be cured?

It is important that these questions are answered early on, to save unnecessary anxiety.

Obviously, parents want to know what kind of difficulties their child has. They often ask*: "Do professionals recognize this kind of difficulty? Have you met other children with similar problems?"* It is important to be honest. If you have not met children with the same kind of difficulties, the parents must be told so. You might have to say: "*I myself have not met many children with this kind of problem, but I will get more information and possibly refer you to a specialist."*

Many parents blame themselves for having done something wrong, or maybe for not doing enough. Most parents can give an accurate description of what their child's difficulties are. However, like teachers, they often find themselves in a situation where they are encouraging too much practice with not much success. Practice is necessary, but it must be the right kind of practice. If the difficulties become too developed, they interfere in the child's hobbies and social life, which are important for their development.

Is dyscalculia curable? The simple answer is yes! The diagnosis dyscalculia is only ever a description of the present stage of development, applicable for a maximum of one year. As the child develops, the difficulties that existed in the previous year can have minimized or may almost disappear.

My own research supports the long term studies of Shalev, to indicate that many children with dyscalculia outgrow their diagnosis after some years.

If the child is getting the right treatment and help, the possibility of development in mathematical ability is greatly increased. However, often some parts of the difficulties remain in a milder form, for example, difficulties with recalling numerical facts. It is usual that the student will continue to have features of those difficulties, in a mild form, throughout adult life. Ability to concentrate, however, usually considerably improves, and with that often comes the understanding of mathematical concepts and symbols.

If the efforts are getting successful or not dues to if the child can keep the lust to work with mathematics.

THOUGHT AND MATHEMATICS

The Power of Thought

It is common to talk about people's emotional problems. Problems with thinking, on the other hand, usually don't occur to us. Do such problems exist, or do these difficulties result from unbalanced emotions?

This raises other important questions: are thoughts and emotions entirely different things? Where are they located in the brain? Do they happen in different places? How do they affect each other? How can we differentiate a thought from an emotion? Which comes first?

Thought is central when we work with mathematics; it is fundamental to the processes of calculating and solving problems. It also plays an obvious part in our feelings of failure. We might think: *"I must be stupid because I can't do what everyone else manages so easily"*. This is a thought, an inner conversation with ourselves, and it is not, initially, an emotion. The emotion comes later, when the negative thought leads to upset and misery. In this way we are obviously affected by our thoughts.

Our thoughts play a major role in our well-being. Thoughts are usually about the past or the future. The present moment we experience mainly through our senses: sight, hearing, smell, taste and feel. When we describe what our senses perceive, however, thought becomes important; we sum up the impressions with thoughts. But thought allows us to do much more; it allows us to move beyond the present moment. Both back, through memories, and forward into the future through our power of imagination. Thoughts express themselves in words, but also in pictures. In adults, they are strongly connected to language. It is actually in our first 2-3 years that our speech develops enough to enable us to use language in our thinking. It takes a few more years, though, before the thinking, the inner dialogue, develops enough so that we can make calculations or plan things for some time in the future, say tomorrow, or in a few days, or maybe a year's time.

When we are thinking clearly, we can think through different alternatives to decisions or actions without having to test out everything we have thought of. This saves time and effort and is a necessity for us to function optimally as human beings. Among other things, we can evaluate the risks of different courses of action in order to avoid running into future difficulties.

Thought is particularly important in solving mathematical tasks. It allows us to make estimations of calculations and judge whether our answers are reasonable: is it reasonable that the distance between London and New York is **1000 km or 10 000 km**? What other known distances can we compare this with? How many kilometers is the earth's circumference? Thought is the essential ally of logic. It enables us to work towards a solution, step by step.

The power of thought is very great, although we sometimes claim that the power of emotion is even greater. We can deflect a thought, but this is not as easy to do with an emotion, which comes back like a boomerang. We may succeed in deflecting an emotion from our conscious thinking, but if it is strong it remains in the body in the form of a vague, expressionless feeling. It is probably the same with difficult thoughts. These also can be pushed away from our conscious awareness, but they remain behind to color our experiences. They are transformed into unconscious references, which may show up later in different situations.

A large enough stock of thoughts about our success and worthiness to be loved will prove to be a helpful friend when we run into difficulties in life. Even if someone rejects us, we are supported by our inner conviction that there are still many people who are there for us. We are sure of being constantly loved, even if one person neglects us.

Thought and Emotion in the Brain

In the past, we have tended to make a clear separation between thinking and feeling. While we associate thinking with the brain, we have historically located emotions outside the brain. Even today we continue to say: *"I love you with all my heart"!* Indeed, it simply doesn't sound right to say*: "I love you with all my brain",* even if this is more correct.

We both think and feel with the brain. Today we know that these two processes even use the same 'paths' in the brain. We use the same nerve channels when we feel as when we think. The difference is mainly that they have different starting places, and that emotions move at double the speed of thoughts. For this reason we sometimes assume that emotions are more powerful. But in fact, they cannot be separated.

What happens to thoughts and emotions when we are frightened? We can all imagine the horror we might feel if we suddenly saw a scorpion on the ground in front of us. What's going on in our brain at that moment? How do the thoughts and emotions about the scorpion occur? Let's take a journey into the brain!

The visual perception of the scorpion travels to the thalamus in the form of an impulse. The thalamus, which is like the switchboard, or main control station, sends a very fast message to the amygdala, which is the brain's alarm. Meanwhile, a sight impulse is also sent to the visual area in the occipital pole, in the rear of the brain, which slowly and consciously interprets the sight impression. By then, the amygdala has already recognized the brief sight impression it received from the thalamus. It interprets it as something dangerous, and the muscles and circulatory system are put on alert via the nervous system. If related memories stored in the amygdala are strong or traumatic, swift feelings of panic may be brought on. When this happens, we don't have the time to think rationally, but act automatically from our overcharged emotions. When the situation calms down, we can later see how our emotions took control over our reason and thoughts.

Modern science has shown that the nerve connections that send impulses from the centre of memory to the amygdala aren't as well developed as the nerve channels that send signals in the opposite direction. What this means is that signals of fear and danger from the amygdala are often stronger than calming signals coming the other way. This is why it is so difficult to talk sense into ourselves using sound reasoning when we are having a panic attack. The fear remains with us for a long time after we experience something frightening. Again, the emotions have really taken over the thoughts.

If the initial sight of the scorpion does not panic us, however, then emotion will not stop thoughts from reaching our conscious mind. We will probably start an inner dialogue about how to handle the situation. If we maintain presence of mind, it is the thoughts that will result in an action. A cold-blooded person may squash the scorpion under the sole of their shoe. Others may take a few careful steps backwards before retreating to a safe distance to calm down. Whatever action results, in this situation it is obvious that it is the thoughts and the power of reason that are in control.

It is extremely important that we react to difficult experiences with thoughts rather than emotions. As soon as an emotional experience is expressed in thoughts and words, it becomes a part of our consciousness that is within our control, even if the emotions are difficult to confront. If, on the other hand, emotional experiences are not formulated into thoughts and words, they often linger in the body, unexpressed and inaccessible. From there they can be easily reactivated in future situations sharing similarities with the original trauma. Even the fear of experiencing the difficult emotions of horror or anxiety may be enough to activate the trauma again. This can trigger a vicious cycle of being 'afraid to be afraid', which can result in people avoiding certain everyday situations in order to escape their fear.

Automatical Thoughts

All of our experiences are stored in our memory. All events are systematized, summarized, and finally separated into categories. It is in this way that we are able to recreate concise thoughts and emotions about how it is to be at a birthday party, eat dinner with the family, meet new people, or learn a new skill. If we have mainly positive thoughts about ourselves and our experiences then there is a great chance that we will continue to react to new circumstances in open and positive ways. New situations all pass through the "filter" of our established thought patterns.

This collection of past experiences often takes its expression in automatic thoughts. These can be both positive and negative. In people who suffer from depression, it is common for a negative thought about themselves, the future, or a current situation, to take control without there being any obvious reason for it. For people suffering from anxiety, such thoughts are usually about catastrophe, threat and danger.

If we think and believe that we will not succeed with mathematics, we will probably seek confirmation of this. This is how negative thoughts are reinforced once they have taken hold. They are further strengthened every time we fail to solve a problem or calculation of a second degree*: "I'm a total failure in math's! I will never succeed! Now everyone can see how stupid I really am…"*

Even though it may sound funny, it is very common for us to protect and nourish our automatic negative thoughts. This is how they contribute to establishing dysfunctional patterns, in which new and future thoughts are affected by old, established thought structures. New thoughts are molded to fit into our established patterns of thought. Then we say: *"What did I tell you?!"*

Automatic thoughts are usually very hard to catch, as they are very fast, and the emotions connected to them are intense and overpowering. We therefore need to learn to restrain our thoughts in order to be able to identify possible dysfunctional patterns. If we don't do this, they will just rush past.

We are our Thoughts

We've all heard the expression *"you are what you eat".* We could also say that we are what we feel, or even we are what we think. Good thoughts often lead to new good thoughts, while negative ones pave the way for just the opposite.

It is not unusual that we feel we need to compensate for our dysfunctional thoughts, especially when we are convinced that we are worthless. In this situation we may compensate by trying to be clever all the time or by being an over-achiever. However, if we experience even an instant of failure, we will immediately trigger the dysfunctional thought patterns*: "I am a failure!"* Thoughts are very powerful; we sometimes talk about their creative power. In the field of medicine it is common knowledge that the placebo effect, or the patient's own belief in the improvement of their condition, accounts for at least one third of all recoveries. This is proof of the great power of thought.

In the field of sports there are many concrete examples of how the power of thought creates winners. Many good athletes create goal-oriented visual images where they imagine themselves receiving the gold medal and being cheered by the crowd. Winning requires mental preparation that should occur well in advance of the competition.

Thought has the power to control both the conscious and subconscious mind. Say we need to get up a little earlier than usual in the morning, because we are going to travel somewhere. Before we go to bed, we concentrate on thinking that we need to be awake by 5am. Many people will find that they naturally wake up a few minutes before the alarm the next morning, because they have set their bodies to wake up at a certain time. Here the conscious thought acts on the subconscious, which goes to work even while the conscious mind is inactive. We do not need to constantly think *"I must get up at 5 am"*. The body manages this on its own.

If we take as our starting point that we are what we think, what then can we make of our thoughts about ourselves? What kind of thoughts are the most powerful? One good exercise to start to explore the thoughts we have about ourselves is to try to think of three things you are good at and three things you would like to change about yourself. Take some time to pick out three positive and three negative things about yourself. Which was the easiest? Listing the things you're good at, or those you're less satisfied with?

How we think of and describe ourselves is an important part of our self-image. Often, though, we do not think conscious thoughts about our whole selves, but rather limit thoughts to particular aspects of ourselves, e.g. *"I'm no good at singing",* or *"I'm quite good at math's".* Our self-image is what comes across when we interact with other people. It is put to the test when we encounter difficult situations, when it becomes readily apparent that we are nothing other than what we think of ourselves, our surroundings and our future.

Thoughts about Mathematics

Mathematics is learnt and taught as a specific subject, but it is really about life itself. Mathematical ability results from our interaction with our surroundings; it initially develops out of our basic need to structure and categorize our surroundings in order to make them more understandable. This need to classify information is believed to be biologically driven. From a very early age, children start grouping things by shape, color and size. Initially this is limited to simple categories, e.g. Cars separated from dolls. Increasingly, however, the categories become more complex, and children learn to consider shape, color and size simultaneously as they categorize.

When there is a need to work out things that have already been memorized, the brain is not working to its maximum capacity. For instance, the automatic ability to identify a number or color may be impaired. It is desirable that such basic skills are ready to be used as needed, so that we don't need to use so much energy to search for simple information such as how to write the number '2', or whether 11 is more or less than 14, or what color you get if you mix blue paint with yellow, or what a 'minus' sign symbolizes, or what is 4x4.

Our brains like to use ready-made charts from which we can retrieve already categorized information and facts. It is most desirable to have these 'charts' already constructed in the mind. If we cannot do this, we need to create them outside of the brain. Written multiplication tables or number charts are some examples. Calculators may also be used to compensate for the lack of mental charts when it comes to simple numerical facts.

There is an old belief that you must be able to do math's of a certain level before you can progress to the next. Today we know that this attitude is far from correct, although it has a tendency to remain in our thinking about mathematics. We could say that it is the 'holy cow' of mathematics: difficult to challenge or change. This old, established view is based on the idea that mathematics is about well-defined thought processes in distinct areas in the brain. Today, however, we know that mathematics demands several different skills that require the whole of the brain to work together. Basic mathematics is language-based rather than visual. Higher mathematics, on the other hand, is more visual or spatial in its nature.

Mostly when we work with mathematics we are focused only on the answer. This means that we are usually satisfied if we get the right answer; if our answer is same as the one on the answer page, then we are happy. I want to emphasize, however, that mathematics is the *process* of arriving at the answer. It is the journey itself that is the goal. When we compare our methods with other people's, we become aware of the reality that there are a multitude of paths that lead us to the goal, i.e. the "right" answer. Of course there are some paths that are faster and therefore more efficient (at least in the short-term), but we can't really claim that any one path is the 'right' path. This is what mathematics is all about. Mathematics is often considered to be an exact science, with a rigid structure and set rules governing the arrangement and calculation of numbers, e.g. addition and multiplication. Nothing could be further from the truth. There isn't only *one* mathematics! Besides, mathematics isn't so much about working out problems as about exploring different patterns and connections. Mathematics is therefore not only a natural science, but a form of art which is constantly evolving.

Thoughts in Mathematics

There are two important aspects of thought that are fundamental to mathematics:

- Recognizing
- Seeing patterns

Thought is central to mental calculations, and is put to the test in different types of problem solving where we must choose between alternatives of action. Carrying out actions in the brain demands the power of thought, but it may save a lot of energy to try out all the alternatives without having to actually test them in action.

Mathematics is about reasoning. It is about logic and rational thought, but even before we get that far it requires that we have the ability to recognize. This is necessary just to read a mathematical text or mathematical symbols. The same process is also used when we rapidly retrieve simple facts such as the times tables from our memory. If these thought processes are not fast or efficient enough, we will expend an unnecessary amount of thought power simply recognizing memorized facts. This will indirectly decrease the available thought power remaining to think about different patterns and connections. Fast recognition is fundamental to the ability to make associations.

All math's is built on recognition and seeing patterns. This is demonstrated in the following example:

We all have a limit to our ability to remember facts. In the case of the multiplication tables, most of us reach this limit at the 11^{th} or 12^{th} table. We might know 13x13, but once we get up to higher numbers like 16x17 we generally don't have the answer stored in our memories. We often have the multiplication of smaller numbers such as 7x7 imprinted in our brains, and can give the answer 49 without thinking about it, regardless of when or where we are asked. This is the characteristic of recognition, an automized process.

Now consider the two calculations:

739 x 738 and 737 x 740

Which of these is larger? How big is the difference between them?

If possible, try to solve the task without paper and pen or a calculator. You will quickly establish that it is not an automized process in which we can immediately recognize the calculation. In other words, we need a strategy with which to tackle the problem. I want to stress that there are many different paths to the answer, even if some of them are more efficient. Let me show you one way to solve the task.

Ask yourself the question: what do the numbers 739, 738, 737 and 740 have in common? They all include the number 737 within them. So now take away 737 from each number and you are left with the 2 calculations:

2 x 1 and 0 x 3

Suddenly it appears much simpler! We have now reduced the problem to calculations that we recognize. They are totally automized. The first calculation is now 2 x 1 = 2, and the second becomes 0 x 3 = 0. Now we know that 739 x 738 is larger, and the difference between the two is 2. Most mathematical thinking consists of a combination of initial strategies (seeing patterns) and rapid, automatic thought processes (recognition). Mathematical difficulties may relate to either of these thought processes or both of them.

Positive Thought Development

The foundations of positive thought development are the development of logic and problem solving abilities and the visualization of goals for motivation. How high should we set our goals? Knowledge and experience from sports psychology, among other things, demonstrates that goals should not be set too low. At the same time, however, they should be realistic.

There is a danger, however, with being too comfortable with a goal. If this is the case, it probably isn't ambitious enough, which means that our thoughts and aspirations which could lead to higher achievements are not being stimulated.

For positive thought development, it might be useful to set a high final goal, and then several smaller goals that will lead to it. For example, our final goal may be to get a 'B' grade in mathematics. Learning the 1-10 times tables might be a smaller goal.

The ability to identify our possible weaknesses or difficulties is essential to positive thought development. It is only after identifying and acknowledging the difficulties that we can start to look for and discuss strategies for overcoming the problems.

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EMOTIONS AND MATHEMATICS

Fear and Enthusiasm

There are few instinctive emotions that can create as much trouble as fear! The only other emotion that can equal it is happiness, which is a powerful motivating force. Happiness generates enthusiasm, while fear creates suffering and anxiety. Happiness gives us energy, while fear drains us of our power, and paralyses us. Happiness creates a sense of desire, while fear usually leads to feelings of aversion.

Fear of failure is a common and overwhelming experience amongst people with learning difficulties. It is not always the case that the fear originates from actual repeated failures in mathematics. It can be born out of our imagination and ideas that math's will be unpleasant or difficult, or perhaps out of a past experience where math's was difficult in one particular context.

Anxiety and fear are biological functions that play a vital role in our survival. As the normal reactions of the nervous system to threat or danger, they are an important part of our 'danger-alert'. However, our brains cannot always distinguish between what is a real threat where fear is justified, and what is our imagination, in which case no real threat exists. The brain reacts in the same way to both situations, by switching on its alarm system.

What is the bodies 'alarm' reaction? It has two different aspects:

- The defense reaction
- The defeat reaction

The defense reaction is commonly known as 'fight or flight'. Stress hormones, mainly adrenalin and noradrenaline, are released and mobilize extra energy reserves (sugar and fat). Our blood pressure increases, our digestion halts, our awareness is sharpened and our breathing and heartbeat quicken. All of this happens so that we are better equipped to handle a threatening situation, by defending our self or escaping. This instinctive reaction has remained the same throughout our evolution over millions of years. The point of the defense reaction is that we use all available resources very rapidly to get ourselves out of immediate danger, after which point our bodies can recover from the short stress.

If the reaction is triggered too often, however, or is too long or extreme, it can be very unhealthy.

In the defeat reaction the main roles are played by the hypothalamus, hypophysis and adrenal gland cortex. The stress hormone cortisole is released from the adrenal gland cortex, which may have short-term beneficial effects by mobilizing us and acting as an alarm signal. Cortisole can, amongst other things, minimize or interrupt the defense reaction. If it remains in high doses over a longer time, however, it will weaken the immune system and leave us open to an increased risk of infection. In the defeat reaction our body reacts to a feeling of defeat or our inability to handle a threatening situation, by increasing the blood pressure but lowering the pulse. Digestive activity increases considerably and more stomach acid is secreted, which can lead to damage of the lining of the stomach. The production of the stress hormone Cortisole rises to increase stress levels, while growth and sex hormones decrease.

Fear and worrying are closely related to anxiety. Moderate worrying makes us more human and empathetic. It helps us to care for our family, friends and relations. You might say that the function of worrying is to strengthen bonds between people. It makes us more sensitive and sympathetic. If anxiety and fear become too strong, however, they can easily transform into a more diffuse anxiety and even result in a panic reaction.

This feeling of panic arises when we experience unbearable fear or our life is at stake. We may be terrified that we are about to die, or that something horrible will happen. Once the fear turns into anxiety, it usually clouds our rational thinking. We simply experience anxiety and panic. The term ‘panic’ here refers to sudden, repeated attacks of anxiety. Panic attacks do not last for long durations of time.

All of the strong emotions described can arise and interfere with or block our learning. If they control our brains for longer periods of time this will unavoidably lead to aversive behavior. We simply seek to avoid everything that may lead to the feeling of anxiety or discomfort. Ultimately, the anxiety connected to one experience in mathematics can lead us to avoid anything to do with counting.

Fear and anxiety are antagonistic to our motivation. It is hard to something when you are afraid of it. If fear and anxiety have taken control, we need to work actively with ourselves to recreate a balanced mental environment that is dominated by motivation, happiness and enthusiasm for learning.

What are we Afraid of?

When strong fear and anxiety step in, the emotions have obviously taken over our thoughts. They are so strong that we do not reasonably question why we are afraid or what there is to be afraid of.

Fear is a strong negative emotion that arises when something or someone is experienced as threatening. We tend to name it rational fear if the threat is obvious, understandable, and comes from an apparent and visible source of danger. We can then say that the fear is motivated. However, if our 'alarm system' becomes too sensitive, the strength of the reaction becomes disproportionate to the reason, so that insignificant impulses can release powerful reactions of anxiety. The reaction may be triggered without any obvious reason. It is unprovoked and no longer works as a survival mechanism, because in this case there is nothing to be afraid of.

This fear is easily born from our imagination. When we imagine horrible things that may occur, we can become uncontrollably afraid. Often these fantasies are far more frightening than reality itself. We may even end up being afraid to be afraid. In this case there is no longer an external threat that we react to, instead, we experience strong unpleasant feelings because of thoughts of being afraid. We simply try to avoid the fear. The paradox is that the more we try to avoid being frightened the more vulnerable we are to fear.

Our brain cannot always differentiate between what is a real threat and what is our imagination. That is why it is necessary to make active judgments and ask ourselves: *"Is there really something to be afraid of? Is there any serious risk of failure in a math's lesson?"* Our thought machinery must learn to challenge emotions, otherwise the fear will take over our capacity for reason and we will end up feeling like a victim of circumstance.

When we feel that we are no longer able to affect a threatening situation then our fear gets even more out of hand. Fear and anxiety can take over to the point where we cannot think clearly. Instead, we may start to act out of fear. This may be expressed in aggressiveness or sloppiness, or we may become quiet, withdrawn and apathetic. In both cases the real issue is how to handle our fear, and neither situation is especially good for learning. However, they both camouflage the fear. Other people see nothing but anger or shyness or reserve, which makes it very hard for them to understand the reason for the fear.

Our Fundamental Emotions

How many emotions do we actually have in our repertoire? Most experts today agree that we experience between 6 to 10 different emotions. A cutting edge model has been developed by S. Tomkin and consists of 9 fundamental emotions, or *affects*, that are combined in different ways when we feel and express ourselves. I will here use the term ‘affect’, which is the term used in most of the models of basic human emotions. It comes from the latin word affe’ctus, meaning “strong movement of the mind”, e.g. excitement, happiness, anger.

Positive affects:
1. Enjoyment - joy
2. Interest - excitement

Neutral affects:
3. Surprise - startle

Negative affects:
4. Anger - rage
5. Fear - terror
6. Distress - anguish
7. Shame - humiliation
8. Disgust
9. Dissmell (reaction to bad smell)

Tomkin´s theory of affect identifies nine basic affects which combine with each other in different ways. We are like a guitar, which creates chords from 8 basic notes. Likewise, our individual personalities are created by unique combinations of affects. Even though they are genetically determined, we use them in a highly personal way.

Each and every affect corresponds to a physiological change. Different emotions, for example fear, happiness or curiosity, are associated with specific facial expressions and body language.

Affects are very similar all over the world, in all cultures; this is why they are assumed to have a biological foundation. There are considerably more negative affects than positive, which, according to an evolutionary perspective, is due to their necessity for our survival.

Happiness is easy to identify. It is an affect which we can recognize from far away when we see someone. Happiness is usually expressed in a pure form. Its main visual characteristic is a laugh or smile.

Curiosity is the second of the two positive affects. It is the basis for concentration and focuses our attention, and is therefore central to learning.

Between the poles of positive and negative we have one neutral affect, which can be either positive or negative: surprise. This affect is unique in that it neutralizes the other affects we experience. When we are surprised, the play of our affects freezes. We experience neither negative nor positive emotions. We ask ourselves: *“What’s that? What’s happening?”* Our eyes open wide, fully prepared to take in the impressions that surprised us.

Among the negative affects, fear plays the most important role, as a trigger for our internal alarm systems to alert us to danger. It is essential to our survival.

The affect anger arises in situations where we don’t get what we want. Sometimes we get angry at events or things, like when your bike chain slips off while you are cycling, or when you find out that tax rates have increased. Other times, we get angry when situations irritate us or do not live up to our expectations, such as when children disturb your much-needed peace, or when you feel neglected or left out by your partner.

Misery is obvious when we grieve. It also arises in situations when we have to do something we really do not want to do. If we know in advance that this will happen, we may be upset for several days. This affect can be long lasting. We can recognize it in a downcast look, or heaviness in shoulders and legs. It is common for children who have given up on mathematics to feel miserable. They think things like: *“Yuck! Now it’s time for math’s again”*, and their misery can be seen clearly on their faces.

Shame is a relational affect, it has to do with relations between people. When we are ashamed we withdraw from others. We don’t want to draw attention to ourselves. Perhaps we feel we have made a fool of ourselves, perhaps because we didn’t know an answer in class or answered a math’s question wrong. We may think: “Now everyone knows how stupid I am! I have made a fool of myself again! I am so ashamed!” We can see when someone is ashamed because they usually blush, becoming red in their cheeks and throat. It happens against our will; *“Who wants everyone to know they feel ashamed?!”*

The last two affect, disgust and distaste, are central to our survival. They are related to our senses of smell and taste, and originally enabled us to quickly identify and spit out spoilt food or other poisonous substances. We recognize these affects in the obvious facial expressions of disgust. These affects are often triggered by conflicts, separations and divorce.

When Emotions Become too Strong

A thought can be deflected, whereas a deeper emotion is much harder to get rid of. They have a tendency to cling until they are resolved.

When is an emotion too strong? It may be any emotion, even though it may seem like there's no problem with having too much joy or curiosity, because these emotions generate enthusiasm and positive energy. But in fact joy can be too strong. Examples of this are when our joy is not shared by someone we like, or when we express strong happiness in a situation when we ought to be sad or withdrawn. In these cases the happiness is quickly replaced by shame about our feelings.

Shame has the ability to muffle other affects and to maintain a distance between us and other people. If we get too close or too enthusiastic about another person, feelings of shame may strike us. We become ashamed of our actions and instantly withdraw. Instead of focusing our attention on our relations to others, we become preoccupied with our own sense of shame. We feel our cheeks get hot and know that others can see that we are ashamed, because our blushing will be obvious to them.

Usually it is the negative affects that create troubles for us. Some stressful situations may trigger all the negative affects, such as when we are anxious about failing in mathematics. We start to discomfort, which develops into strong feelings of anxiety each time we go to a math's lesson. This means that even before we begin the mathematics, we are already emotionally blocked. We might feel that we are worthless. Maybe we also feel shame. Or the feelings of shame turn into anger, and maybe even hatred towards those horrible, boring math's lessons. We may also feel bitterness, and justify all of our negative emotions with the thought: *"I hate mathematics! "*

When negative emotions become too strong, as a way of defense we often avoid the situations that cause them. Both experiences of repeated failures and feelings of shame are hard to deal with. However, through using avoidance strategies there is a risk that the emotions take expression in another form, including:

- Avoiding the situation that caused them
- Blaming yourself
- Blaming/attacking others
- Attacking yourself

The pain we experience from feelings of shame can lead us to avoid at all cost situations in which we may feel ashamed of ourselves. We often blame ourselves for not being smart enough, and then talk ourselves into it: "*It's because I'm so stupid!*" We put a label on ourselves that we then use in other situations where we fail.

When emotions become extremely out of control it may lead to attacks on other people who have difficulties. The child who laughs at other people's failures is usually themselves afraid of failing. The feeling of shame about one's own weaknesses finds expression in an attack on those who are weaker and more vulnerable.

Another way of avoiding feelings of shame is by acting the clown. By assuming this role, you can do to yourself exactly what you are afraid that others are going to do to you, ridicule you or put you down. You beat them to it by doing it yourself, and at the same time, deflect attention away from your failure.

Most defense strategies like these work without our conscious knowledge. In order to change our patterns, therefore, we must begin with an awareness of which defense strategies we use. It is idealistic to think that people with mathematical difficulties will consciously think: **"***I find mathematics difficult! I feel ashamed to fail. I feel stupid and different and I avoid this situation at every cost. I even act badly towards others just to avoid the feeling that I am ashamed of my own efforts."*

In reality a student will need to participate in a trusting dialogue in order to start to become aware of their own feelings. You can't expect the student to progress unless your communication with them is open and trusting.

When Motivation Becomes too Weak

Motivation generates energy and when it becomes too weak, joy and enthusiasm are often lacking. This doesn't only affect one particular school subject, but the whole life situation of a child. When they are experiencing less joy and satisfaction, the negative affects are playing a larger role. It is not unusual for negative thoughts about oneself to totally take over. Other doubts can also arise about others' ability and desire to help, or worries and anxieties about the future may develop.

Once we start to doubt other peoples' desire to help us, a form of depression sets in. Most of a child's energy can be expended in anxious thoughts about what will happen later on.

Emotions are the forces that motivate us into action. Affects are seen as the primary motivating forces. In its simplest form, motivation arises from curiosity. It is triggered by surprising incidents which stimulate the child's interest and curiosity to make further explorations. We recognize this positive curiosity in such questions as: "*What was that? That seems exciting! I want to know more about this!*"

To be able to maintain motivation, a genuine feeling of success is essential. As long as a child has this feeling, they are aware of their competency and not only their limitations. The desire to keep learning increases.

Success is a feeling we all crave. We are happy and satisfied when we accomplish something, whether it is studying, homework, or something important at work. But the initial feeling is one of curiosity. That is what gives us a thirst for knowledge and the will to learn. It helps us to direct our attention and makes us focused on the task.

As we progress our motivation is further refined. Gradually we come to feel joy in sharing our knowledge and values with other people. When we successfully communicate our knowledge and share common ideas, our desire to learn further increases. However, it takes time to reach to this point.

Many children need to be push-started by adults because they are not driven by a forceful inner motivation. In the short term it is okay for this *external motivation* to provide the driving force. Ultimately, though, if adults have to drag the child through the school work, the effort is bound to fail. Encouraging a reluctant child to work is extremely energy-draining, and rarely leads to an increase in the child's own motivation. It can even prevent the possibility of the development of inner motivation.

Stimulating motivation is dependent on strengthening the child's self-image, self esteem, and positive goals. Only once these foundations are strong can you proceed with the learning. It is just like a car with no petrol. You can make it go forward by pushing it from behind, but it gets too heavy very quickly. It's so much easier when you put in some petrol and the car starts going by itself. It this that motivates us to keep driving.

Pride, Motivation and Happiness

To feel pride about ourselves and our achievements is one of the finest things we can experience. It strengthens our self confidence and self esteem.

Pride is the opposite of shame. While shame makes us shrink into ourselves, pride makes us to expand outwards and feel clever and competent.

Some children easily slip into negative thoughts: "*I don't know that. I don't want to do that. I'm not good at math's!*" Such children run the risk of losing the ability to feel proud of themselves. If feelings of worthlessness surface in one area in life there is often a tendency for the emotion to be generalized to other situations as well. For example, a person who has difficulties drawing or writing may generalize their negative self-image to not being able to count because they can't write down the numbers and calculations very well. This feeling can occur even though in actual fact they are really a good counter, if they don't have to worry writing anything down.

Pride arises from the combination of the positive affects, curiosity and happiness. Pride exist in our emotions and takes expression in our thoughts. It is experienced when we have done something well or achieved a goal. It can be seen outwardly: someone who is proud of themselves usually wants people to notice them. They are happy, and feel a sense of worth about themselves. They have a strong feeling of satisfaction that they have done something positive. It might be a good result in a math's test, or praise from a teacher for good work. It may also be praise for helping someone in a generous way.

There is a false form of pride that on the surface seems like "true" pride. It is easily distinguishable, however, because it gives way to boasting. You can sense that the speaker is lacking in self esteem by the way they puff themselves up and make out that they are more successful or accomplished than they really are. "True" pride, on the other hand, is built on an honest story - when there is obviously something to be proud about. What counts as a source of pride is a very individual thing. We know that pride keeps interest and curiosity alive. It creates happiness and the desire to learn, and is contagious for other people. It enables the positive affects to overthrow the negative.

ASSESSING DYSCALCULIA

The Path to Better Understanding

At what point is it necessary to assess whether a student has dyscalculia? Most children and adults are never assessed despite their difficulties with mathematics.

In most cases it is possible to identify the problems are and provide suitable help. The student's progress confirms that you are doing the right thing and an assessment is therefore not necessary, unless it is specifically required by the school.

However, if a student does not progress despite intensive help efforts, there is a definite need for an in-depth assessment which will provide a clear understanding of the student's specific learning difficulties. This solid understanding of the nature of the problem, when combined with the right skills and resources, becomes the foundation for the right kind of help. It is essential to determine not only what needs to be practiced, but also what should be avoided. Each of these is as important as the other.

What should an assessment consist of? A qualified assessment of the student's skills and difficulties has three parts:

- **Neuropedagogical test**
- **Neuropsychological test**
- **Neuropediatric test**

The initial assessment should be conducted at the student's school by the teacher in collaboration with the school psychologist or school doctor.

More complex cases need to be referred to a specialist team, usually known as child neuropsychiatric- or neuropsychological teams. They should not be contacted, however, before a thorough assessment is undertaken in the student's own school.

If a student is experiencing widespread learning difficulties there is a good reason to conduct an in-depth assessment. The old adage about learning from our mistakes is not relevant here! Occasional mistakes can be instructive, but if they are frequently repeated it is easy for the problems to become deeply rooted. This often leads to emotional blockings that then hamper further development.

Parents and teachers usually wonder what they have done wrong or whether they should have handled the child's problem in another way. They have many unanswered questions, some of which are urgent while others remain in the background, not even properly formulated:

- **What is the reason for the difficulties?**
- **Have we done something wrong?**
- **How can we help?**
- **Does the student need special help?**
- **Will the student catch up with her friends?**
- **Can she be cured?**

It is important that these questions are acknowledged and addressed. The aim of a comprehensive in-depth assessment is not merely to make a diagnosis. Its main aim is to provide the basis for a deeper understanding of the problem, to identify the student's strengths, and to map out future directions for remedial work.

Even when the learning difficulties seem to be limited to mathematics, an in-depth assessment should also involve an examination of reading and writing ability. While most students who have mathematical learning difficulties have straightforward problems with mathematics, many also have reading and writing difficulties. Because of this cross-over, it is also important to test mathematical ability when assessing dyslexia.

The Neuropedagogical Assessment

Tests should initially be conducted by teachers and school psychologists, who know the student and the school environment well. After this initial stage, it is usually helpful to invite other teachers to meet the student and participate in the assessment. This allows us to observe how the student works with other adults, in different situations and with different tasks.

A good neuropedagogical assessment should include an examination of:

- **Mathematical knowledge and understanding**
- **Reading ability and comprehension**
- **Writing ability and spelling**

In the neuropedagogical assessment it is essential to take a broad perspective and observe the student's performance as a whole. It is important to pay attention not only to their score in the tests but also to how they solve the tasks. The main question to ask ourselves is: With what aids can the student solve tasks that she couldn't manage on her own? This question points to the direction that the remedial work needs to take.

It is essential that the person or people conducting the neuropedagogical assessment are familiar with the examination material being used. This enables them to examine the more qualitative aspects of the test, through observing the student's cooperation, communication, motivation and self-esteem.

The student's abilities will be related to his cognitive and emotional development. In the neuropedagogical assessment it is important that we have a broad perspective. Practically, what this means is that we don't only examine the students skills in mathematics, but also observe his way of communicating and taking in and processing information. We should examine:

- **The student's handling of oral, written and visual information**
- **The student's strategies for solving specific tasks**
- **The student's general learning strategies**
- **The student's attitude to their own learning ability**
- **The student's motivation**

We need to gain an understanding of how the student takes in and processes sensory information. For example, does she seem to do better with written tasks than with oral ones? Does she need visual aids to accompany oral instructions, i.e. does she need to have the information written down on paper?

We also need to understand the student's strategies for solving mathematical tasks. Does he stick to the same strategy from beginning to end, or does he get lost during the process of trying to solve the task? Does he cling to the wrong strategy even though it doesn't help him solve the task?

The student's overall learning strategies affect her ability to solve specific problems. Our personal learning tendencies fall somewhere along a spectrum between *qualitative* and *quantitative* characteristics. Most people will favor either one or the other.

The quantitative character is good at language and prefers to express herself verbally. She is good at solving problems that are deductive or those that require a sequential strategy. She is also good at quantitative operations. When the student gets a problem, that can get presented orally, the student looks for similar algorithm to find the solution. She works best with well-structured information and instructions.

The qualitative character approaches problems from a more holistic perspective. He develops global, general strategies for problem-solving. He is good at recognizing patterns, both spatial and symbolic, and responds best to information presented visually or in picture form.

The student's beliefs about their own ability to manage a task strongly affect their chance of success. It is not unusual for students to say (or think*): "I can't do this! I will fail with this task! I'm not good at this sort of thing!"* If she is used to repeated failures with similar kind of tasks it is highly likely that how she approaches the task will be affected. She may have a preconception about the outcome which will negatively affect her effort and motivation.

The 'affects', or basic emotions, greatly affect our level of motivation. Students who feel anxious about certain tasks have a low motivation level. Motivation is fundamental to the ability to learn, and must therefore be examined in an in-depth neuropedagogical assessment. Success and achievements provide motivation and usually create a sustained enthusiasm for learning.

Many students experience disinterest, dislike, boredom, and anxiety in learning. They are sometimes burdened by worry when they think about mathematics, which directly affects their motivation. These students form preconceived ideas, which lead to involuntary emotions and thoughts such as: "*Mathematics will be no more fun today than it was yesterday. How long will we be doing math's today?"* This question indicates distress and anxiety, and presents a huge obstacle to motivation. Such students usually need an element of surprise to be incorporated into their learning. This relieves distress, at least for a while.

The neuropedagogical assessment should assess the following aspects of the student's performance:

- Communication and interaction with his environment
- Progress in lessons
- Mathematical knowledge and skills
- Understanding of mathematics
- Reading ability and comprehension
- Writing and spelling ability
- Strategies for the own work

Teachers usually develop a close relation with their students, and for this reason are well-positioned to form a clear picture of a student's interaction with her peers and with adults. A student's learning ability is affected not only by problems inside the classroom, but also outside, in the playground or during play time. Being bullied or very lonely in the playground is enough reason for not wanting to learn in class.

Questions about how the student interacts with peers and adults are also important when we examine specific difficulties in mathematics. Questions to be answered include: “*How does he interact with his peers? Does he have any close friends? Does he like school?”*

Students with learning difficulties usually have problems with concentration. This phrase may seem to suggest a specific type of problem, but in fact it is commonly misunderstood. What do we really mean when we say that a student has difficulties concentrating? Often we mean that the student lacks the ability to focus and work independently on a task from start to finish. However this more accurately describes what might be called *working maturity.* This distinction makes it clearer to everybody, including the parents, what concentration problems are really about. In a neuropedagogical assessment we should instead ask the following questions: “*How is the student’s mental stamina? Is it different in different tasks? When is it strongest? Is the lack of mental stamina due to the student’s incapability in the subject, or is it because they lack enthusiasm or will? How well developed is the student’s working memory? What differences are observed when information presented verbally/orally or visually/written? Is the student easily distracted by people, noise, or other stimuli?*”

The neuropedagogical assessment also involves mathematical tests. These are standardized for different age groups, and show us how the student performs in comparison with others of the same age across the country. These mathematical tests alone, however, are not sufficient. They do not distinguish between students who have specific mathematical difficulties and those with more general difficulties with this kind of test. Often, students skip questions, leaving sections of the test blank, and we therefore don’t have enough information to determine whether their problems are caused by general learning difficulties, emotional blockings or difficulties with certain cognitive functions. We need more information in order to make a proper assessment: we need to examine the basic cognitive functions that are necessary for different parts of mathematics. I have developed the Mathematical Screening package as a way of systematizing the observations.

The package is not suitable for use as a general test for all students in a certain age group or grade. Further, is it not designed to be used on groups of students with different types of mathematical difficulties. It is designed for use in individual assessments.

Mathematical Screening was developed to enable teachers and child psychologists to identify student’s difficulties with the underlying cognitive processes which affect their mathematical ability. It is these underlying processes that create mathematical difficulties, but they are also visible in other school subjects as well as in the student’s day to day life.

Examining Cognitive Functions with Mathematical Screening

A student's numerical competence and skill with calculations must be examined thoroughly in a neuropedagogical assessment.

Mathematical Screening is not a conventional standardized mathematical test, although it is designed to be manageable for most students of a certain age. The examiner should note carefully if a student is unable to solve a particular task; this is a warning sign.

The following skills are examined in Mathematical Screening:

- Understanding number structure
- Understanding number sequence
- Simple counting operations
- Complex counting operations
- Understanding arithmetic signs and symbols
- Numerical comprehension
- Understanding geometrical figures
- Understanding spatial relations
- Spatial memory
- Planning ability
- Time planning
- Temporal orientation

Mathematical Screening is specially designed to assess students understanding (knowledge) of mathematical concepts and their numerical comprehension separately to the assessment of the actual working out (doing) of different mathematical (cognitive) tasks.

Understanding number structure refers to the ability to read, copy and write numbers and calculations. In the assessment, it is helpful to use numbers that include zeroes, because this gives us information about the student's ability to "see" the zeroes in the calculations. Some students have difficulties writing numbers such as 1005 (one thousand and five), where the zeroes are silent. It is also helpful to use numbers like sixteen and seventeen, which when read aloud seemingly begin with what is actually the second digit, i.e. "six" and "seven".

Understanding number sequence involves the ability to keep track of number order. This allows us to work out quickly how much greater one number is than another, e.g. 91 and 89, or which of two numbers is the largest, e.g. 2001 or 1999.

Understanding of number sequence can also be tested in tasks involving counting backwards. For adults, the task may be to count backwards in sevens from 70: seventy, sixty three and so on.

The ability to do simple counting operations is tested in Mathematical Screening with simple calculations, e.g. 7 + 8 or 4 x 4. In this type of task we are testing how well the student has automized simple counting operations. We observe whether she can make the calculations mentally, or whether she needs to use her fingers. You need to be especially alert when working with older students. They usually don't do it obviously, but hide their hands under the table. Sometimes it is necessary to ask them directly: Did you count on your fingers? for absolute clarification. It is not unusual to get the response: "*Yes, how did you know that?"*

We should also investigate the student's ability to handle more complex counting operations. This we can do with relatively simple tasks such as 8 + 9 – 7, where the solution requires at least 2 steps. This task again tests the student's level of Automatization, and it also tests his ability to count in his head, where the working memory plays an integral part. Finally, this type of task assesses the student's level of concentration.

Knowledge about and skills in using arithmetic signs are tested in written tasks such as 8   2 = 16 where the student must fill in the correct arithmetic sign. The task requires them to be able to recognize and differentiate between addition, subtraction, multiplication and division, and identify the particular counting method. Tasks of this kind test the student's understanding of the symbolic function of arithmetic signs. Sometimes a student will know what kind of calculation should be used but still has difficulties remembering how the arithmetic signs are written. Sometimes it is the opposite: a student may know how to write the sign, but is uncertain about how it should be used.

The student's numerical comprehension is also examined in Mathematical Screening. This involves testing the student's ability to identify which of two numbers is larger, e.g. 96 or 69. If the student has problems with reading direction and sometimes reads from right to left, the first number may be read as sixty nine while the second becomes ninety six. The student's wrong answer therefore results from their reading the numbers incorrectly. It is also common for students to mistake the value of numbers when presented visually, e.g. 1889 and 2001. Some students select eighteen hundred and eighty nine as the larger number because it contains higher digits (8, 8, 9) than two thousand and one (0, 0, 1). Other tasks to test numerical comprehension are those like

27 -   = 18

or   9 +   = 24

where one number in a calculation is left out. These types of tasks cannot be automatized, but demand a deeper understanding.

Finally, numerical comprehension is examined through tasks involving a picture showing different objects arranged in a line, in which the student has to identify the position of the objects, e.g. point to the second last object or the fourth object.

This task tests the student's understanding of number order, a concept central to mathematics.

Understanding geometrical figures becomes important in the mathematics that is taught from 10-12 years of age. We therefore need to examine the student's ability to both copy a picture and to recreate it from memory.

Tasks of this kind show us whether the student has mastered basic perceptual skills. It is important to note the nature of the difficulty. Does she notice that what she copies down is wrong? Does the student see that her figure is wrong but is still unable to draw an exact copy? Mathematical Screening assesses the ability to recognize spatial relations between complex figures that are copied down or retrieved from memory. Spatial ability enables us to observe a problem and "see" the solution without directly expressing it in words or concrete thoughts.

Time planning ability and having a conceptual understanding of time are fundamental cognitive functions that allow us to see things as a whole. Mathematical Screening tests these abilities in tasks where the student must fill in the numbers on a blank clock. Other tasks require the student to estimate what they can achieve in a certain time. After they attempt the action in the stated time, they then evaluate the outcome, in order to correct their own judgment of time. This is an example of a task that requires both planning ability and a sense of time. These are essential in mathematics, and are an important foundation for calculations and logical thinking.

Mathematical Screening is available in three versions, for ages 7-8 years (version I), 11-12 years (version II) and 16-17 years (version III; this also is an adult version). It is an essential supplement to standard mathematical tests and is central to a neuropedagogical assessment. For further information and or to purchase a package, please contact:

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Examining Reading and Writing Ability

A comprehensive neuropedagogical assessment will also involve as assessment of:

- Reading ability and comprehension
- Writing ability and spelling

Reading requires different skills to writing, and therefore the two abilities are examined separately. As mentioned previously, dyslexia is the inability to automatically recognize words and letters. It indirectly leads to poor reading comprehension, although this is a secondary problem caused by disinterest in and difficulty with reading. If a text is read out orally, the dyslexic student will usually have no difficulties with comprehension.

Writing difficulties, known as dyspraxia, stem from difficulties with transforming thoughts and ideas into concrete action. The dyspraxic student can often count in his head, but has problems when using concrete material. Writing problems are also sometimes caused by difficulties with fine motor skills or hand-eye coordination, which may make it difficult for the student to handle a pencil. Finally, difficulties with spelling have a completely different set of causes again. They can be traced to specific language difficulties, including problems with sequential memory (working memory).The student may have difficulties in seeing or hearing how a word is spelled. Pronunciation difficulties might also contribute to problems with spelling.

In a neuropedagogical assessment we will therefore investigate possible difficulties in all of the different areas of mathematics, reading and writing. We will identify patterns that provide a clear picture about the nature of the student's specific difficulties. From this clear picture, we can develop suitable support strategies. We will have created the necessary foundation for the right level and type of remedial work.

The Neuropsychological Assessment

These tests are made by a neuropsychologist. The neuropsychological assessment examines the connection between the functioning of our brain and our behavior. Neuropsychological assessments, excluding the examination of mathematical skills and knowledge, are undertaken in cases of:

- Dyslexia
- Dyspraxia and dysgrafia
- Attention Deficit Disorder (ADD)

- Asperger syndrome
- Tourette syndrome
- Schizophrenia
- Autism
- Epilepsy
- Skull trauma, brain tumors, stroke

In most cases the patient has no obvious brain damage, but is experiencing problems with certain cognitive functions, leading to:

- Uneven development
- Attention difficulties
- Lack of concentration and mental stamina
- Specific learning difficulties
- Restlessness, hyperactivity
- Perceptual difficulties
- Problems with speed tasks
- Poor motor skills
- Lack of motor coordination

Uneven development can be caused by cognitive processes, or emotional or social immaturity. It is common for students with learning difficulties to have delayed emotional development. They often have younger friends.

A comprehensive neuropsychological assessment examines three fundamental things:

- Personality
- Cognitive development
- Specific neuropsychological processes

The assessment aims to describe how the student functions cognitively and psychologically, in terms of, for example, how he solves different types of tasks.

Assessing personality

Childhood years are crucial for the development of our personalities and identity. The term personality refers to the stable and interconnected set of thoughts, emotions and actions that uniquely characterize each of us as individuals.

Young children express their personality naturally through play. In later childhood and adolescence this expression is gradually replaced by verbal communication.

Play is meaningful and aids development because it allows the child to take in and adapt information and explore and expand their thoughts and emotions. For example, it is healthy for children to work with their fears through play, such as fears of doctors or fears about failing.

When a child doesn't like to play or can't play, this is a warning signal. She is in need of stimulation and help to develop this ability.

Through observing play, and later communication, we can examine a child's ability to organize their world and interact with their environment. It is especially important to observe the child's:

- Interaction
- Communication
- Behavior

From watching children playing or talking to one another we can get valuable knowledge that allows us to hypothesize about the individual's difficulties. A situation in which a trusted adult provides material that stimulates the "affects" or basic emotions can also helpful in order to observe the student's underlying emotions and conflicts.

Having the student draw or paint a picture gives further information about their self-image and emotional and cognitive maturity. It is important to observe their communication while they are drawing. Some children cover the picture while they draw and may say things like: I'm no good at drawing! What insight does this give us into their self-image?
Free play, as well as communication, leads to simultaneous emotional and cognitive development. Sometimes, thought, play can become an escape. This is common in children who are aware that they have huge trouble with learning. Instead of acknowledging these difficulties, and working with them, the child might use play as a distraction. This leads to them refusing to face new challenges and possibly results in developmental delays.

Play provides essential relaxation and reflection for children. It significantly decreases the likelihood of stress and exhaustion.

In modern personality theory, personality is commonly separated into two components:

- Temperament
- Character

Genetic and behavioral science research indicates that temperament is mainly inherited from our parents, while our character is formed by our childhood environment. Personality is the unique combination of our individual temperament and character and the interaction between those. Our temperament affects our vitality, ability to control mental impulses and ability to form close relationships, while our character affects our ability to set and achieve goals and to work cooperatively with others, as well as our religious, superstitious or spiritual beliefs.

A fiery temperament, which needs constant stimulation and excitement, must be balanced by clear goals and deliberate cooperation and the sharing of experiences with other people. At the other end of the scale, a cool temperament results in an anxious and phobic personality, which needs to be stimulated to try new things and step beyond the comfort zone.

Psychologists usually use a variety of personality tests to assess an individual's personality. Personality tests are built on models which describe the individual and their reactions in a general way.

An important question in the personality test is: *"How does the individual see herself?"* Also; does the image accord with how others see her, including you. Having a common picture makes communication easier, even if you don't really understand each other, or have the same thoughts and feelings.

According to behavioral and genetic science, our environment is a stronger influencing factor than our genes on our personality traits and development. Genes play a larger role, however, in our cognitive development.

Assessing of cognitive development

Initial assessments of cognitive development initially are made from standardized intelligence tests. Wechsler's Preschool and Primary Scale of Intelligence (WPPSI) is used for children aged 3-7 years. On school children, aged 6-16 years, Wechsler's Intelligence Scale for Children (WISC-III) is used. For students over 16 we use Wechslers Adult Intelligent Scale (WAIS). These intelligence tests are commonly used in most countries throughout the world.

The assessment of cognitive development is made by a psychologist. It provides us with an empirical measure of how the individual performs in different tasks. We are interested not only in the answers to the problems, but we are also looking for information on the process that has lead to the solution of the tasks. We need to get a clear understanding of the strategies the student uses, including:

- Processing information
- Flexibility in working out solutions
- Strategies

The questions we need to ask are: How does the student absorb and process information? What are their strengths and weaknesses? Do they follow a strategy through, or get lost in the process? Do they abandon strategies that work?

Alertness and concentration are also assessed in this section of the psychological assessment. Is the student easily distracted by stimuli from the surroundings? Is he more sensitive to sound or visual impressions? Is he sensitive to a certain kind of sound or light? We also look at his work to give us indications about his concentration, mental stamina, attentiveness, motor control and planning ability.

The next stage of the neuropsychological assessment is to observe the student to attempting tasks, taking note of right and wrong answers as well as which aids enable her to solve tasks that she can't manage by herself. For example, do visual, verbal or kinesthetic aids help more?

The cognitive assessment is a fundamental part of the overall assessment of dyscalculia. To be able to make a positive diagnosis we must confirm that the student's mathematical ability is clearly below average for his age, while his overall intelligence and performance at school is normal.

Assessing specific functions

In the psychological assessment we start with a wide perspective where different aspects of personality and cognitive development are all illuminated. This is extremely important, because people with learning difficulties can have problems in various different areas. The abilities that need to be tested are:

- Attention, control and concentration
- Motor coordination and sensory integration
- Basic perception
- Spatial ability
- Imagination
- Language ability, including comprehension
- Memory and learning strategies

It is important to differentiate between general delayed development and signs of neuropsychological symptoms. By the time a child starts school, we should already have an idea about the causes of emerging difficulties and whether they are specific or general in their nature. Particular cognitive functions are assessed by a psychologist with the aid of specific tests. A closer examination of certain specific functions may then be required, e.g. visuo-spatial memory, visual construction ability. Results from the general section of the assessment will indicate which specific aspects need to be further examined.

The neuropsychological assessment describes the student's current level of functioning, but can't very easily predict his future development, therefore it is essential that all assessments (including medical and pedagogical are recent and up-to-date. Assessments that are more than a year old, in the case of children, and two years for adults, should be considered invalid.

Although the neuropsychological assessment may be done at 4-5 years of age, a diagnosis should not be made until the child is 10-12, when their brain is sufficiently developed to make a safe diagnosis.

The Neuropediatric Assessment

Part of the assessment is a medical health test, and is usually carried out by a pediatrician, although sometimes it is done instead by a school doctor, district doctor, child psychiatrist or neurologist. In some cases a specially qualified physiotherapist is also called upon to help with the medical assessment.

An important part of the assessment is the medical history and the background. This shows us how the student is functioning in a range of different situations: at school, in the family, and doing homework and other activities. We also check the student's childhood medical record for incidences of diseases or other traumatic events.

The medical assessment includes a physical examination, which allows us to examine and eliminate neurological disturbances and serious progressive diseases as causes of the difficulties.

It also involves a neurological examination. It asses the following abilities:

- Fine motor skills
- General motor skills
- Coordination
- Perception
- Balance
- Lateral thinking
- Muscle tone
- Concentration and mental stamina
- Automatization of movement
- Motor planning and conscious movement

The aim of the assessment is to find possible neurological deviations that may contribute to an understanding of the individual's symptoms.

Motor skills are sometimes described as the foundation of psychological development.They are strongly linked to perception, and for this reason it is more correct to talk about motor-perceptual development. An example of an aspect of writing ability that is assessed in the medical assessment is eye-hand coordination. Sight, general motor skills, and especially fine motor skills, are all important parts of perception. Writing requires adequate muscle tension, and balance and stability are necessary for neat writing. If these are lacking and a student is required to write out a long paragraph, more demands are placed on her energy, concentration, and motor planning in the task. If the process of writing letters and words is automatized, however, we see an obvious flow; the student writes easily, and her energy can be directed to the content of what she is writing.

Some children have not displayed a clear hand-preference by the time they start school, evident in their ability to write as well with the left hand as with the right. Sometimes they can use both hands during the one task of writing or drawing, depending on which part of the paper they are using. At such an early age this is not a sign of dysfunction, but is a neurological symptom and indicates a lack of neurological development. However, it must be interpreted in light of other developmental delays.

When we consider the movements of a baby it is obvious that movement comes naturally to us. Babies have a large surplus of movement: they wave their arms and kick their legs for no apparent reason. This process enables them to progressively refine and learn to control their movements. They go through four stages in this process:

- Excessive movement
- Choice of movement
- Refining the choice of movement
- Automatizing the choices through practice

Part of the medical assessment involves an examination of the student's ability to automatize movements, by giving her simple exercises requiring motor skill, to be practiced until they become automatized. Many children have problems learning new schemes for movement during their development. Such children take longer to learn to ride a bicycle, to swim and to write. Another common problem is not being able to run fluently. Running fast requires hip-joint mobility and muscle strength in the thighs and calves, but it also requires coordination, balance and automatization.

Motor skill and coordination provides the basis for everyday things like seeing, eating and talking. Chinestetic perception is examined by testing motor control.

Tactile perception is the ability to feel and interpret touch. Some people develop a tactile defense reaction, shown in their negative emotional reaction to touch sensations. Such children may insist on wearing clothes of a particular material, or only eat foods of a certain texture. This reaction results from the over-sensitivity of the connection between sensory receivers and the nervous system, creating feelings of unpleasantness linked to strong sensory impressions. The same child may be insensitive to other impressions. A child with tactile defense needs more touch and body contact than other children, due to her difficulties regulating her reaction to impressions.

Our bodily coordination and sense of space comes from the sensations of movement and gravity combined with information from muscles, joints and the skin. When visual impressions are integrated properly, we have a bodily ease and a comfortable sense of our space. We orient ourselves with the help of the vestibularis (the organ of balance in our inner ear) and the integration of visual and hearing impressions.

Difficulties with perception and motor skills are usually caused by sensory interpretation problems, which means that some people have problems interpreting different sensory impressions (sight, hearing, feeling, smell and taste) into something meaningful. It is extremely rarely to find their ability totally lacking.

If a child has problems interpreting visual impressions, we often find early signs of the following symptoms in the medical history:

- Problems focusing the eyes
- Problems crawling and walking
- Tendency to repeat actions/get stuck on activities
- Difficulty learning new things
- Over or under sensitivity to sound and touch
- Stress and anxiety in new situations
- Delayed speech development
- Excessive motor activity

Problems with focus contact are evident in difficulties looking at objects during play or following objects or people who are moving. Many late developers have difficulties focusing on their mothers and fathers and the parents often struggle to make and hold eye-contact with the baby. Sometimes this ability is not developed until 1 year of age.

The movements required for crawling and walking are programmed into our central nervous system from birth. Little children do not normally need to be taught how to crawl or walk. They do it spontaneously and automatize it through practice. However, some children’s development is delayed, and they may have difficulties learning to crawl or walk. Sometimes the opposite occurs: the child learns how to walk early and from then on is constantly moving and active. In some cases, this develops into hyperactivity, which means the child has general difficulties with concentration and sitting still.

The tendency to get stuck on activities can be seen in children who are fixated on certain toys or games, usually those that feel safe and easy to handle. Often such fixations indicate a clinging to familiar environments and anxiety in new situations.

If a child has difficulties learning new things, the ordinary accomplishments of drawing, throwing and catching a ball, swimming or riding a bicycle will be delayed. Often such children take a much longer time than normal to learn skills, but once they are accomplished they usually remain.

Difficulties with coordination and integration of sense-impressions into a meaning full whole can lead to over or under sensitivity to different sense-impressions. One moment the child can react very negatively to a certain sound and then in another situation, not react at all to exactly the same sound. This can also happen with light, touch, smell and taste sensations.

Delayed speech can also be a sign of late maturity. Some children only speak a few words by the time they are three. Often they have problems with pronunciation, and actually understand considerably more than they can express themselves. However sometimes children have problems producing sounds and words and also have difficulty understanding what they hear.

Compiling the Team Assessment

When all the sections of the assessment are complete they are compiled into a comprehensive analysis. This combined assessment is the result of team work, with different people from specialized fields working within separate frameworks. Although the frameworks sometimes overlap, they each provide unique and specific knowledge about the individual.

The purpose of the combined team assessment is not only to make a diagnosis, but to identify the individual's strengths and weaknesses in order to gain an increased understanding of their symptoms and difficulties. This creates a solid foundation for future remedial work, both at home and at school. When making a diagnosis, it is extremely important to consider all possible explanations for the symptoms and difficulties displayed. Sometimes a student will be diagnosed with two 'overlapping' conditions, and to be able to offer the right treatment it is necessary to identify which is the main diagnosis.

The in-depth assessment will be presented to the teacher, parents and student in a clear, understandable way. Everyone who deals with the student will be provided with information, and their input will be supported by a concrete remedial program, designed to be suitable for daily practice sessions.

Diagnoses and examples of remedial programs will be thoroughly discussed in the following chapter.

THE DIAGNOSIS

From Assessment to Diagnosis

The basic principal of good health care is to first make a diagnosis and then start appropriate treatment. It is difficult, and highly inappropriate, to start treatment before we know what causes someone's symptoms.

A good assessment should primarily focus on increasing the understanding of the individual's difficulties, and secondly aim to make a specific diagnosis. The diagnosis is a summary of explanations for the range of symptoms displayed. It is significant because it leads to specialized, individualized treatment for the individual.

When dyscalculia is diagnosed, the treatment is not medical in nature. Instead, a supportive environment of special remedial work is proscribed. Dyscalculia and dyslexia are special types of diagnoses that are made within the domain of medical care by health care professionals, but are usually treated outside of this domain, in school and at home.

The medical field relies strongly on diagnoses to plan and structure health care and distribute resources among different kinds of diagnoses.

The Diagnosis Dyscalculia

Dyscalculia is not a disease. Nor is it necessarily a chronic condition. Our body and mind form a dynamic equilibrium that is constantly changing and adapting to new situations. What this means is that with the correct support, a student's cognitive abilities can progress beyond his original diagnosis. Students can work through or grow out of specific mathematical difficulties, although the problems often do tend to remain with them into adulthood. It is important to understand, therefore, that assessments are only valid for a relatively short time. We should not strongly rely on assessments that are more than one year old when dealing with children and youths. For adults, an up-to-date assessment needs to be less than two years old.

Making a diagnosis is a medical concept. Over the centuries, medical science has constructed a biological model out of its progressive understanding that different disorders require different treatment. This model has enabled us to develop standardized worldwide classification systems for diseases. Today there are two such predominant systems. ICD-10 (International Statistical Classification of Diseases, Injuries and Causes of Death), is published by the World Health Organization (WHO) and is already in its tenth revision. Its aim is to create a universal standard and stable foundation for the development of medical science.

Due to its early criticism of the ICD system, the American Psychiatrists Association, (APA), developed the alternate DSM (Diagnostic and Statistical Manual). One of the main goals of the DSM is to provide an accurate description of all medical symptoms so that by consulting it doctors or health care professionals can make a correct diagnosis. Swedish psychiatry has conventionally used the DSM, but as a result of EU changes in the past year we have had to integrate the ICD-10 into practice. Today, therefore, Sweden has two parallel diagnosis classification systems. We will illustrate the use of each in the diagnosis of mathematical difficulties.

In the ICD-10, dyscalculia is named as a specific mathematical difficulty and is defined as follows:

> ”315.1 Specific arithmetical retardation
>
> - Disorders in which the main feature is a serious impairment in the development of arithmetical skills which is not explicable in terms of general intellectual retardation or of inadequate schooling.
>
> Dyscalculia”

The ICD-10 further describes how, in the case of dyscalculia, the individual’s mathematical ability will be lower than average for her age, and also lower than her general intelligence. It suggests that the problems should be investigated with the use of individual, standardized mathematical tests. Reading and spelling ability should fall within the normal range: these skills should also be assessed using individualized tests.

Before a positive diagnosis is made, causes such as inadequate or incorrect teaching, problems with vision, hearing or neurological damage, or neurological or psychiatric disease, should be eliminated.

The ICD-10 goes on to state that mathematical problems can vary greatly and can be caused by lack of understanding of mathematical concepts or signs and symbols. It lists among other difficulties the inability to recognize numerical symbols, carry out normal counting operations, apply the relevant calculation in a concrete task, or work out calculations in different ways. Finally it mentions problems with using decimal signs or other symbols, the inability to organize counting tasks spatially, and problems learning multiplication facts.

The problems listed in the ICD-10 related to different forms of mathematical difficulties.

The DSM IV also specifies that in order to make a diagnosis of dyscalculia, the difficulties should not be able to be explained by below-average intelligence or poor education, and states that in the case of dyscalculia:

- “As measured by a standardized test that is given individually, the person's mathematical ability is substantially less than you would expect considering age, intelligence and education.
- This deficiency materially impedes academic achievement or daily living.
- If there is also a sensory defect, the mathematics deficiency is worse than you would expect with it.”

Difficulties will be marked by a significant disturbance in school work and other activities that require counting skill.

Before making a diagnosis it is important to test for psychiatric or neurological disease, e.g. an individual with obsessive compulsive disorder might find counting and general learning difficult because of their uncontrollable tendency towards compulsive thoughts and actions. Strong anxiety or other affective disturbances can also inhibit our ability to learn. Negative psychiatric symptoms commonly occur in conjunction with dyscalculia, ranging from lack of self esteem and self confidence to suicidal thoughts and feelings. These symptoms should be seen as subordinate and secondary to the mathematical difficulties.

Overlapping Diagnoses

What about individuals who have specific mathematical difficulties as well as difficulties with reading or spelling? Do we diagnose them with more than one condition? How do we diagnose individuals who have average intelligence but also have problems with several different areas of learning?

Studies shows that up to one third of students have difficulties with both counting and reading. Often they have trouble with the automatization process, which leads to difficulties with reading fluently and retrieving number facts from memory. The figure below shows the margin of overlap for the three major diagnosis groups dyscalculia, dyslexia and dyspraxia.
Problems with both counting and reading or spelling are diagnosed as *mixed development disorder* (ICD-10). General learning disturbances which cannot be

diagnosed as specific problems, but can neither be explained by below-average intelligence or poor education, fit into this category.

Many individuals whose difficulties are limited to counting usually don't have problems with audio-perception or linguistic skills, but they may have troubles in day to day life. A person with dyscalculia often has difficulty reading an analog clock (with hands), while a dyslexic person has problems reading a digital clock (with numbers). People with dyscalculia usually have problems with visual perception and spatial relations, while people with dyslexia have difficulties with reading and interpreting numbers and symbols.

Dyscalculia and Acalculia

Acalculia is the total inability to use numbers, do calculations and work with symbolic mathematical signs and symbols. It is a severe form of mathematical learning difficulty, and is relatively rare. It probably only occurs in 0.1% of the population, and is usually caused by brain damage.

Dyscalculia and acalculia are distinctly separate conditions. Dyscalculia relates to difficulties with specific cognitive functions. It does not include the total lack of mathematical ability found in acalculia.

Dyscalculia and General Mathematical Difficulties

General mathematical difficulties are evident when a student has problems that are not limited to specific areas. Usually such students need to take more time in all learning.

Intelligence tests conducted by psychologists, as well as special pedagogical tests, are important in differentiating between general learning difficulties and specific problems. If a student's general intelligence is below average (IQ 100), we can expect that his mathematical ability will be similarly slow. Conventionally, the cut-off point for schools for students with mental disabilities is IQ 70. Considering that one sixth of the total population has an IQ of below 85, there is a large group of students in regular schools who cannot be expected to achieve average or high results. Working at a slower pace, and with simplified teaching material, is usually the best support for students with these general difficulties.

Dyscalculia and Pseudo-dyscalculia

The emotions meaning to efforts in the subject of mathematics is important. Pseudo-dyscalculia causes the same difficulties as dyscalculia, but the explanation for the difficulties lies not in cognitive dysfunction but in the psycho-social environment, i.e. in emotional blockings, or a family history of failure in mathematics. In these cases, the student fails because they do not expect to succeed; just the opposite, they have a clear expectation of failure.

Because the mathematical difficulties may due to emotional blockings, it is important that the psychologist tests not only cognitive intelligence but also of personality and emotional maturity. In pseudo dyscalculia, no obvious cognitive dysfunction occurs that can explain the mathematical difficulties. Instead lack of self esteem, feelings of stupidity and other types of emotional blockings which lead to expectation of mathematical failure are evident. Difficulties may also arise due to gaps in learning. Girls have more trouble with mathematics and are diagnosed with pseudo-dyscalculia more frequently than boys, although their intelligence and potential for mathematical success is equal.

Dyscalculia and ADD

There is a link between dyscalculia and ADD (attention deficits), as well as other learning difficulties, the main one being dyslexia.

The most common problems that cross-over are those of attention and working memory, which are fundamental to working with mathematics. However, other symptoms of ADD may affect mathematical ability indirectly (as well as other types of learning). These include severe concentration difficulties, being easily disturbed, and problems learning to draw, read and write letters and numbers, as well as difficulties with planning, keeping to a strategy, and generalizing learned knowledge.

Children with ADHD (**A**ttention **D**eficit **H**yperactivity **D**isorder) have a high incidence of other learning difficulties. Problems with counting, reading and writing may occur for more than half of the individuals in this diagnosis group.

It is my experience that most people with dyscalculia are not primarily hyperactive or inattentive, but that their difficulties are mainly caused by other specific, cognitive dysfunctions. For this reason, an ADD diagnosis rarely explains serious problems in mathematics alone. ADD is primarily a diagnosis of behavior, while dyscalculia and dyslexia in high regard makes out the pedagogical diagnosis.

The Time-span and Implications of the Diagnosis

Assessment of a student's difficulties should be done at an early stage, as soon as their problems with learning become obvious and best even before school starts. A diagnosis, on the other hand, should not be made before 10 years of age at the earliest.

A diagnosis is in itself an important foundation for planning for the right help. It provides the basis for correct remedial work and enables us to set a reasonable level of demand. Usually assessments and diagnoses should be renewed every 1-2 years.

When the diagnosis dyscalculia is made, a remedial program should be commenced at the student's school. This program should also be run for students who have not been diagnosed but are in need of specialized pedagogical support.

A student who has been positively diagnosed should be allowed to use technical aids, for example, when doing mathematical tests. Dyslexic students now have the opportunity to have test questions asked verbally and to answer them verbally. In the same way it is reasonable for a student with dyscalculia who has extreme difficulty remembering number facts and doing simple counting operations but at the same time understands the principals of counting and has a good problem solving ability to use a calculator for mathematical tests.

Mathematical difficulties usually do not disappear by themselves; the student usually requires continual help with mathematics, despite doing well in other subjects. It is not helpful to let the student pass out of 'kindness' if they do not achieve the required grade, because this only allows the problems to be pushed on into senior high school, where the student may have the same problems keeping up in the subject.

From a social perspective the diagnosis is extremely important because resources are allocated according to information and statistics about the different diagnosis groups. If students with dyscalculia are not diagnosed, adequate social resources will not be committed to helping this large group.

There are as many people with dyscalculia as there are with dyslexia, i.e. a minimum of 6% of the population. An even larger amount, up to 20%, fails mathematics in primary school, which indicates that we are dealing with a large problem in society demands new thinking, and a new approach.

Dyscalculia has existed as a medical diagnosis for several years, but there are different types of mathematical difficulties that require different types of help. The assessment and diagnosis are therefore extremely important.

In modern medical practice, the making of diagnoses for somatic disease is automatic. Dyscalculia, dyslexia and dyspraxia should be no exception: people with these conditions have an equal right to diagnosis.

HELP WORK

From Diagnosis to the Help

A diagnosis should not be seen as the only way to help. A proper *diagnosis* of *dyscalculia* or *dyslexia* cannot be made before 10 years of age at the very earliest, but help need not take so long.

If a child's difficulties are apparent before they have started school, a first estimation should be made at that time. Help should begin early, even if the formal diagnosis cannot be made until 10-12 years old.

Not all help is good. Just as when it comes to physical injuries it is important to relearn motor skills in the right way, so do people with dyscalculia need to practice specific exercises to help overcome their problem.

Some forms of "help" can even have a negative effect. That's why it's important to focus not only on the quantity but also the quality of practice exercises. Sometimes 30 minutes of individual and specialized help from an informed psychologist or teacher may be more beneficial than 4 hours in a group in which the students have totally different problems and needs.

If a student starts practicing in areas in which it is impossible or very difficult for them to progress, they run the risk of encountering problems that prevent their development in higher mathematics. It is sometimes desirable and even essential for a student with dyscalculia to continue working on a higher level, although they may have problems with the groundwork. Their brain might need these challenges in order to stimulate maximum cognitive development.

It is of utmost importance that remedial work helps the student to succeed, otherwise they may form emotional blockings which will present serious obstacles to future learning, not only in the field of mathematics. It is definitely better not to practice at all than to practice in the wrong way.

A General Model

Programs for overcoming *specific learning difficulties in mathematics* should result from *collaborative effort* between parents, teachers and others involved with the student, for example school counselors and child psychologists. The program should be oriented towards confidence building and success.

Students with learning difficulties in mathematics are frequently struck by the feeling that they are “stupid”, and without psychological, as well as remedial, support they will eventually give up on math. Often these signs of defeat become clear during adolescence. At this age, however, it can be difficult to understand the reasons for refusal to learn. Maybe the student is disorganized and anxious, or plays up in class, or expresses extreme boredom. Possibly they start to play truant or refuse to go to school. They stop the long, unsuccessful, evening practice sessions. Often their sense of failure is shared by their parents and teachers. Eventually nobody has the energy to continue, not the student themselves, the parents or the teachers.

Sometimes the cause of the difficulties is sought in the student’s social or family background, for instance, in lack of support from the parents. It is true that occasionally this can provide an explanation. In the majority of cases, however, students with mathematical difficulties have competent parents who have supported them throughout their whole school career, despite their mathematical failure.

No one appreciates too much help, especially adolescents, who are trying to liberate themselves from the restraints of childhood and move into the adult world. We must therefore begin remedial work at an early stage, during the first few years of school. The program must enable the student to work independently, despite learning difficulties. Any obvious problems should be openly discussed with the student, to avoid negative psychological effects developing before or during adolescence. A good collaborative model would be clear and well structured, in a way that provides relevant support.

In a collaborative help effort it is important for everyone involved to do what he or she is best at, and which is his or her primary responsibility. Parents should continue parenting, and the school should provide specialist teachers and counselors. It is important that parents do not undertake the role of teaching for hours each night when their child comes home from school. This will prevent them from living a normal family life, and deprive the student of essential leisure time and interaction with peers.

It is important that collaborative help is formulated around a common assessment of the student’s needs and difficulties, even if the program requires each person involved to maintain separate responsibilities. It is useful to formulate a *joint idea* of exactly how the student needs to develop in regards to there:

- Emotional development
- Cognitive ability
- Knowledge expansion

- Maturity in learning

The student should be given challenging tasks, but these must be of the right level. We must form a clear understanding of their abilities, knowledge level, and skills in working independently in different situations. This will then inform the difficulty of the remedial tasks. At all times we must focus on eliminating the risk of repeated failure.
The remedial program will only have positive effects if we can decrease the *stress* the student experiences. When stress is reduced, the student becomes more receptive to learning and their memory ability dramatically improves.

Sometimes the feeling of stress can be so familiar to the student that they no longer notice the warning signals, such as:

- Problems with concentration
- Problems with memory
- Reduced problem-solving ability
- Lethargy
- Insomnia
- Irritability
- Thought interruptions; compulsive thoughts
- Anxiety
- Pain in muscles and joints
- Feelings of worthlessness
- Listlessness
- Increased sensitivity to stress

These symptoms usually endure over time, and can be serious.

Stress reactions are important and even necessary for survival and functioning in a fast-changing modern society. If stress reactions occur often, however, or are violent, or continue for long periods of time, they can contribute to sickness and disease such as heart disease, psychological disturbance, and decreased immunity.

The Action Plan

There is some risk that the people supporting a student with mathematical learning difficulties might rush into the role of "helper" before a common consensus has been reached about what kind of help the student actually needs. Often parents feel the difficulties have gone on for such a long time and that their child is now so far behind that they want instant results. Teachers can also be struck by the feeling that work must begin immediately, that "*there's no time to* *lose*". This feeling may be especially strong if there is already a feeling that much of the remedial resources have been spent on assessing the student's condition and needs. If a student has already been assessed, it is extremely important to follow up with a comprehensive collaborative program.

Special support should be offered to all students who are in need of remedial help. First of all, support should be given within the classroom itself. Secondly, if deemed necessary, support can be provided in a special learning group. This can be arranged on the decision of the school board, in consultation with the student and parents.

It is very important that the program is well *documented* by the school. It is also important that students, parents and teachers are participating as equal partners in the program. Special support should be given to every student who fails or is at risk of failing a single subject. It is extremely important that the decision about what help to give is based on assessment of the student's abilities. Sometimes it may be desirable to seek expert advice outside the school, usually from the medical care neuro-psychiatric team

Formal remedial programs are usually long-term, and therefore requires continuous follow-up in the form of an *individualized written action plan.*

How will the program be implemented? It is important for each school to have clear and established procedures for running such a program. One of the most essential steps is the compiling of all assessments and help measures for each student into a single *action plan*. The action plan should be understood and agreed on by the student themselves, their teachers and their parents.

The action plan should rest on knowledge about the student's abilities and their general well being at school. Consideration of the following aspects can provide guidance:

- Mathematical knowledge and skills
- Maturity in the classroom
- Self-image and self-esteem
- Self-knowledge of strengths and weaknesses
- Interest in, motivation for and enjoyment of learning
- Relations to peers and adults
- Strengths in learning, social interaction and interests

The *action plan* should be developed by teachers, parents and the student themselves, working in collaboration. It is most important that it has a *clearly stated and agreed goal*. This main goal should be further broken down into several smaller goals. It is insufficient to aim solely for the student's *success in mathematics*. The student's special needs, and the means and methods suitable to meet these needs, must be defined and agreed on. The program should precisely outline:

- Means
- Method
- Time-frame
- The main executor of the program
- Evaluation strategies

It should be clear in the action plan which resources are available (the means), and how the people involved will work to achieve the goal (the method). A time frame should also be specified, i.e., for how long and how often should help sessions run? The program should not only be directed towards mathematical success. It is of equal importance to work with social interaction and self-esteem.

One person should be mainly responsible for the implementation and evaluation of the program. This person should be agreed upon from the outset.

A successful action plan will include the following features:

- Professional presentation
- Clearly assigned responsibility
- Realistic goals
- Clearly defined structure
- Collaboration and allocation of roles

It is important that every school finds a simple but effective way to systematically document each student's progress, relevant assessments, and the development of the program itself. Everyone involved in the program should receive regularly up-dated copies of the action plan. Nobody should need to wonder about the status of any specific aspect of the program at any time.

Relieving the Problem

We all know how beneficial a good conversation or close personal meeting can be. Our psyche has a natural ability to heal itself and create positive energy. But for this to occur we need to share our experiences with other people. Open meetings that allow the student to communicate closely and honestly with adults can provide enough security for them to express difficult emotions in words.

Problems with learning almost inevitably lead to disturbed or volatile emotions and thoughts. This is particularly so for students who are good at reading but have problems with mathematics. Such students experience a lot of *frustration*.

This can lead to the development of strong feelings of *anxiety* and *shame*, connected to repeated failures.

Children usually know as soon as school starts how their own performance compares to others in their class. They know who comes top and bottom in their math's class. If we see that a student already has difficulties with parts of mathematics when they start school, we should not wait to see how they progress. We should support the student in their feelings and experiences and immediately begin a dialogue between the involved parties to establish which kind of help and strategies the student needs for their development.

We should talk openly with the student about their problems with mathematics for a few minutes at a time, a couple of times a week. Through these talks, the student's experiences are validated, because they are able to share their thoughts and feelings with someone important. This process may turn experiences of *frustration, anxiety* and *disinterest* into feelings of *stimulation, confidence* and *motivation*. Although the student will still have problems with some parts of mathematics, help, in the form of directed practice and good strategies, will turn the sense of defeat into one of competence and victory.

Reducing the Problem

It is important that help for specific mathematical difficulties be given on an individual basis for it to be maximally beneficial and efficient.

Students with specific difficulties in mathematics are not a uniform group, and it is therefore ineffective to teach them in groups. It is necessary for the student to practice their specific program individually, for a period every day, ideally 20-30 minutes. Individual practice is more efficient but also more intense, so that the student usually cannot concentrate for more than 30 minutes at a time. This may not sound like much, but in this kind of program it is quality and not quantity that counts. If the student spends several hours a day in a special learning group with other students, it is probable that their specific difficulties will not be addressed. There is a great risk that the student will not receive the right help at the right level, which will lead to new failures and confirmations that is of no use to work with math.

In the action plan, tasks that are reasonable and meaningful for the student to practice should be clearly stated. Priorities should also be listed, so that the student's day to day life is not completely consumed by their remedial practice.

Compensating for the Problem

We need to be aware of the frequent demanding and stressful situations a student with dyscalculia finds themselves in. The majority of the student's day is not spent doing remedial work, but inside the classroom. It is therefore of utmost importance that the help program enables the student to work to some extent independently. This cannot necessarily be achieved while the student's efforts are focused on strengthening their areas of weakness. We need to decide which path should be given priority.

In the classroom the student should receive enough technical and remedial support to enable them to partly compensate for their difficulties. If the student has problems retrieving multiplication tables or other numerical facts from memory, or has not automatized simple counting operations, then they should be allowed to use a calculator in class, to have the multiplication tables written down, or to have a number-line in front of them on their desk. There should not be a limit to the number of technical aids a student can use. The purpose of this allowance is to compensate for the absence of "maps" and "tables" that are usually stored in the memory.

To prepare and organize material that allows the student to work independently in the classroom usually requires the specialized knowledge of a child psychologist, school counselor, or specialist teacher.

Relearning

When the learning difficulties are so severe that the student has not progressed despite many years of hard work, it may be necessary to consider *relearning*. The ability to read math's relies largely on understanding mathematical symbols. This is based mainly on the establishment of "mental tables" for the recognition of letters, numbers, and symbols, in order to interpret written mathematical formulas and problems. Reading math's also relies on the principle of reading problems from left to right. The "mental tables" include multiplication tables, tables for basic arithmetic, and number lines for working out number order. Once these tables are memorized we can multiply *7 by 7* or quickly work out which of the numbers *1998* or *2001* is the largest even if we have just been woken up in the middle of the night.

In the case of the skilled counter symbol recognition is *automatized* through constant repeated practice. Once this is achieved, we are not required to expend a huge amount effort in this part of the task. We can instead use our energy to analyze the problem and think out different possible solutions and strategies. This second part of the process can never be completely automatized, because it develops all the time as we think and get new ideas.

If the fundamental difficulties are so severe that the student does not progress in mathematics despite huge effort, we should consider starting again from the beginning. This can be considered with students up to 12 years of age, although it should be possible to use this method with adults as well.

The main aim of *relearning* is to establish the following skills through repeated practice:

- numerical literacy – fluently reading and writing numbers and calculations
- fast performance of simple arithmetic
- fast assessment of relative number value
- fast selection the appropriate operation for a problem
- fast recognition of mathematical symbols
- fast identification of differences in shape and size of geometrical figures
- fast conversions from one unit of measurement to another

Relearning allows the student to automatize basic mathematical skills so that more energy can be devoted to reasoning, problem solving and discovering associations. This leads to *mathematical understanding*.

Many students have knowledge-gaps in addition to their specific difficulties, resulting from their falling behind in class. Such gaps may further contribute to the need for relearning basic mathematics. This technique assumes that the student is aware of their problem with mathematics and that they are willing to make a fresh start.

Working with Numerical Comprehension

There are several abilities relating to numerical comprehension, such as the ability to order numbers in a set. People without a clear understanding of number value will have serious difficulties with such a task.

The basic building blocks of number value are the positive integers *1-9*. Combinations of these make up all higher numbers.

Many students have difficulties recognizing written numbers and calculations, which means that they waste too much energy trying to make sense of what they see. This almost always leads to indirect problems with attention and concentration during the task. Such a student usually needs more time to learn to read and write numbers and mathematical signs. At the same time, it is also important that they are given challenges at a higher level, partly because this stimulates cognitive development and partly because it increases the student's will and motivation.

Using numbers as substitutes for concrete objects requires an understanding of what numbers are. At the beginning of school, most students have not yet reached this level of understanding. Mathematics at this early stage tends to be more of a memory skill. The young student simply remembers that *5+3* are *8*. Once the student reaches 10 -12 years of age, they begin to understand the concept of number and can then understand the real meaning of the symbols.

Problems with understanding number value may result from confusion about *left-right* orientation. In a number line, numbers are sorted by size from left to right. If a student is unsure about the direction of the number line, it is easy for them to confuse the size of the numbers. They may also have problems comparing multi-digit numbers such as *901* and *899*, because they are unable to discern which are the relevant digits to the task of ordering. *Eight hundred and eighty nine* may indeed seem to be the larger, because it contains higher-value digits.

In the case of a student displaying problems with size and relations between numbers, a written number line may be of help. If they are confused about *left and right*, a “help-arrow” can be added to written problems in a math’s textbook, pointing to the right. Exercises working with the *right* and *left* sides of the body may also help to overcome this problem.

If a student has problems with numerical comprehension, it is essential to work on this separately and intensely. Sometimes this requires shifting the focus from working with calculations and arithmetic to working with concepts of *numerical value* and *mathematical reasoning*. Tasks may involve comparisons of different geometrical shapes and sizes, as well as problem solving. However, it may be necessary to continue the work in concrete mathematics simultaneously. We must take into consideration that the student may need higher-level challenges to stimulate motivation and development.

Numbers represent *amounts*, but also *measurements* and *rank*. When working with measurements, the number is always followed by a unit of measurement, e.g. 1000 **meters** or 2.5 **liters**. When an integer is used as an ordinal number it gives us information about where in a certain order that number or its representative object is, e.g. *second, fifth, first*. The number order also creates a sequence that moves from left to right. The first number or item occurs to the farthest left.

Working with Automatization

Mathematical reasoning can never be automized. However, certain fundamental mathematical skills and facts can be, such as multiplication tables, or identifying and applying arithmetic symbols, and it is important that we create mental ‘charts’ that allow us to automize these functions. When recognition of such facts is instant and effortless, the student does not waste mental energy in laboriously searching for information stored in their memory.

Many students with difficulties automatizing basic functions display uneven results in mathematics. On some occasions they can quickly recall multiplication facts, but on others, everything seems to be lost. This usually indicates that a student has problems with automatization, not memory. They are simply unable to access stored information fast enough. If the problem is severe the student should be allowed to use technical aids. These may include having the multiplication tables written down, or using a calculator. If such allowances are not made, the student will be greatly hindered by the process of finding information in the memory. This retrieval process can consume most of their time and energy in even the simplest arithmetic. They won't get much math's done!

Tasks for strengthening automatization should be practiced on a one-on-one basis. In the classroom, however, where the student is expected to work more independently, it is necessary that the tasks in each lesson are screened so that the student will have the greatest possible chance to succeed.

Students, who have problems with automatization of, for example, multiplication facts often also have problems in day to day tasks in which most people rely on previously learnt information. If this is the case, the student will be using a lot more mental energy than usual to do things or solve daily tasks. They will need to take frequent short rests during the day.

If, during practice, the student is unable to retrieve a particular fact from memory, we should move on to a completely different task. A while later, or in the next session, we can return to the original task. The knowledge may now be more easily accessible. Stubbornly continuing with the same task after repeated failures is a futile task, leading to psychological blockings in the student, and the exacerbation of the original problem.

Practicing atomization tasks should be done periodically in short sessions, only a couple of minutes at a time. Longer time periods are usually ineffective because the student can't sustain concentration. Overly long practice sessions may have a negative effect on their atomization functions.

Lack of rapid improvement despite correct practice is usually linked to problems with concentration. We may need to cultivate an environment of calmness when teaching students new skills. Once the skill has been acquired, however, it usually remains.

Working with Language Comprehension

The student needs to practice exercises involving various material objects in order to understand the nature of different qualities, and the meanings of such descriptors as color, shape, thickness, length and surface. In mathematics there are also special words that require special attention. Each part of mathematics has its own terminology, for example, "*addition*", "*positive integers*", "*ordinal numbers*", or "*equilateral triangle*".

The concept of *relative size* is fundamental to mathematics. A great part of mathematics involves determining, and making calculations of, size difference. To help us we use *comparative words* such as *big*, *bigger* and *biggest* and *small*, *smaller* and *smallest*. A linguistic understanding of comparisons is essential to mathematical ability. It encompasses understanding relative value (e.g. *many*, *more*, *most*), and describing a number in a sequence (e.g. *first*, *second*, *third*, *fourth*…).

If a student has difficulties with comprehension and recognition of the integers 1-9, we should still continue to work with higher numbers. The two rely on different cognitive processes. Working with the numbers 1-9 mainly requires number recognition, whereas working with higher numbers demands deeper linguistic understanding.

There is a simple principle which states that it is usually easier to discern the relative value of two numbers that are further away from each other rather than two that are closer together, for example *99-41* as against *99-98*. There is a visual component to this ability by which we see (visually identify) the numbers and then decide which is the biggest. The other component, however, is a linguistic one.

Reading negative numbers can be especially difficult, as these do not conform to our ideas about how you can and should handle numbers. For example, how do you add two negative numbers? How do you add a negative number to a positive? Here we have different concepts of *amount* that aren't directly comparable to each other. In subtraction, we start from a *whole amount* and then take away one or more *parts*. In addition, we start with the component parts and arrive at a whole amount.

Many students need visual aids in the form of a number line of negative and positive numbers. This enables them to better exercise their problem-solving ability when doing subtraction.

An important foundation for understanding what a number is, is the comprehension that each number represents an amount. Another important insight is that a smaller number is part of a larger number. *77* is part of the number *100*. When added to *23*, *77* becomes *100*. It does not matter in which order you add the two parts. *23+77* is the same as *77+23*.

Differentiating between the *parts* and the *whole* is based on the ability to use numbers and arithmetic to decide what is *bigger than* and *less than*. The mathematical concept of significance here is that of *relativity*: whether a number is large or not depends on the numbers with which it is compared. *9* is a small number compared with *999* but large in comparison to *0.009*.

The student must, when reading multi-digit numbers, overcome an ambiguity where the separate digits in a (relatively) small number may be nevertheless larger than those in a larger number, e.g. *889 & 901*. The number *nine hundred and one* is the larger, but the individual digits in *eight hundred and eighty nine* are larger than those of *901*.

A related confusion arises from mistaking the physical size of a number for its numerical size, e.g. *3* & *9*. Students who have such will be unable to resolve the tension between what they see and which one is mathematically bigger.

Working with Concentration and Attention

Concentration is a cognitive ability that helps us overcome the brain's natural limitations in processing sensory impressions. It enables us to discriminate between the different types of information that bombard the sensory receptors in the brain. If the impressions are intense enough, and thereby trigger strong emotions, we do not even need to make a conscious decision to act on them. Much more energy is needed, however, to recognize the significance of a weaker impression, especially when it requires mentally blocking out more insistent or stronger signals.

Attention and concentration play a very important part in all learning and are also of great importance when interacting with our direct surroundings.

The student might need concrete help with focusing their attention. If a student has difficulties to differentiate between significant and irrelevant sounds in the classroom, they will also run into difficulties with remembering and completing a task. Many students with difficulties in mathematics also display concentration problems, which indirectly affect their ability to focus on the task. A calm surrounding with reduced auditory and visual stimulation is extremely beneficial for improved attention and concentration, and can indirectly lead to increased learning ability.

Computer work can provide valuable support to students who have problems with auditory learning. The computer gives a clear visual structure that helps the student to remain focused on the task. Computer work alone, however, is inadequate, and should only be used as a complement to other important methods.

Hyperactive students who need to be constantly active can be helped to sustain their concentration if they are allowed to play with something in their hands, e.g. a lump of clay. They should also be enabled to take short, controlled breaks. These should be arranged in such a way as to minimize the disturbance to both the student concerned and others in the class.

Over all you seldom need to worry that the student will abuse their privilege. On the contrary, such allowances are necessary so that the student leans to recognize when they should take a break without becoming unfocused and disruptive.

Concentration and attention are best aided through preparation and structure. It is especially important to:

- Give written, as well as verbal, instructions and information
- Repeat and write down instructions
- Have frequent eye contact with the student
- Have the student sit close to you so that they are less easily distracted
- Break down tasks into smaller, more manageable parts
- Take many short, planned breaks
- Switch tasks frequently

It is important that the student is motivated to successfully complete their tasks. If this is a problem, the task should be so short that there is no risk of failure. Otherwise the student can develop the “bad habit” of interrupting activities as soon as they become the slightest bit tired, experience difficulties, or suddenly lose interest.

Working with Perception and Spatial skill

Imagination plays a large role in spatial ability. To have what we term *spatial understanding*, we must be able to form a concept of whatever lies beyond our ordinary sense impressions, ie. that which lies out of reach of our physical touch, or our sight or hearing.

A sense of *body and space* is necessary for spatial ability. Both are usually pretty well developed before school starts.

These skills are of great importance for the student’s ability to read numbers and letters in the right direction from left to right. Many students have problems with this, and shift direction as they read. The number *98* may be read incorrectly as *89* and therefore gives an incorrect answer. The problems are usually most obvious when the student is tired or lacks concentration. This may be mistaken for carelessness and disinterest, when it is actually what is known as a *lateral difficulty*, caused by the student's inability to automatically ascertain the correct reading direction. Visual support in the textbook in the form of a clear arrow that points from left to right can often help.

Problems with spatial ability can also result in difficulties with physically interacting with one's environment. Even if their motor skills are normal, the student may appear to be clumsy for their age. This can be much improved by marking off a special workspace for them, with at least one arm-length to their closest friend. It is also important to appropriately organize the material that they have on their desk. This reduces the likelihood that they lose written instructions or repeatedly drop objects like pens and erasers.

To practice body awareness through physical exercises can sometimes be beneficial. It is most important that these exercises are fun and enjoyable. They should be presented as an ordinary part of day to day life.

Visuo-spatial difficulties can be overcome by a simple "calculation-window" cut out of white paper and placed over the page in the textbook. Through the window the student can see only one or a few math's problems at a time, which decreases the tendency for the student to get lost or confused seeing all the math's problems at once.

Sometimes it can be valuable to mark changes in counting operations, by using different colors to show shifts from addition to subtraction, etc. For example, minus symbols may be marked in red.

On a higher level, spatial ability is about the ability to *imagine*. This becomes important once the student is asked to think out different possible solutions to a problem without the process being fully spelt out. The student needs to use imagination to predict the outcome of the different possible solutions, in order to select the best one.

Spatial ability is central in all learning. Albert Einstein is reported to have said that *imagination is more important then knowledge, because while knowledge refers to all we already know, imagination illuminates everything beyond.*

Spatial ability is also fundamental in the reading of the analog clock (with hands). Here an ability to memorise a visual cue is necessary while the arithmetic is completed. The analog clock gives only partial information, so that telling the time is largely a mental calculation.

If the difficulties are extreme, it may be necessary to use a digital clock at first, because it is much easier to read. However this measure will not work for dyslexic students. Furthermore, it will not improve a student's temporal awareness, i.e. their feeling for time.

Working with the Temporal Awareness

"Time" is a concept, and therefore a product of thought. To have an awareness of more than the instant NOW requires among other things an ability to remember, and above all an ability to *divide one's attention*, i.e. to keep many experiences in the memory and be able to shift between those. If a student doesn't have this ability, they will inevitably have difficulties with developing their feeling for time.

Many students who have problems with temporal awareness have difficulties structuring their whole existence. To this purpose, visual cues in the form of pictures and written schedules help the student prepare for upcoming activities, while keeping track of what has already been done. A picture or written schedule has a clear advantage over speech, in that it can be kept and referred to repeatedly during the day.

Temporal awareness can be improved through time-planning exercises, where the student tries to estimate what they can achieve in 10 minutes. After this has been written down, the student attempts to carry out the task. When 10 minutes is up, the student's time-plan can be compared with the time it took for them to complete the task. It is important to discuss with the student how they might coordinate their conception of time to the actual time. For example, discussion may revolve around where the student's estimation went wrong if they finished the task in 13 minutes instead of 10.

Temporal awareness is a continuous process because it requires constant practice. It demands our constant attention to and awareness of time. We must be aware of time in order not to lose it.

The 'time continuum' can be explored through an exercise in which the students form groups in different corners of the classroom to discuss the *present, past (memories) or future*. It is generally important for students to practice relating memories from past times and particularly their thoughts about, and visions of, the future. This is because the future, unlike past and present, has the special quality of being moulded by our own imaginations.

Working with the Memory

In learning, memory is fundamental. Actual memory disabilities are rare. When a student displays problems with memory, this is usually the indirect affect of lack of concentration and attention.

Storing information in the long-term memory is best done when we are not stressed and have time to reflect during the memorizing process. This is the optimal learning situation we need to create.

The key to a better memory lies in practicing different *strategies* for remembering, rather than simply practicing memorizing things over and over again.

The first step is often the admission that you need better memorising strategies. If this insight does not occur then you probably will not develop new strategies. A student with problems remembering verbal information but better visual memory should have learning tasks presented via their stronger "channel".

Through experience we know that the working memory can be trained. We can simply train ourselves to remember and juggle many tasks at the same time. For this reason it can be useful to learn such things as songs by heart, not only because it is enjoyable but also to practice memorising.

Good memory is little more than strategies to recognize and see patterns in what you remember. A good chess player can remember the placement of pieces in a game if they are placed in a meaningful and logical way. On the other hand, they will not remember better than anyone else will if the pieces are randomly placed.

Mind maps provide a structured visual form where text and pictures are summed up in written memory charts. For most students with learning difficulties, however, this form of memory strategy is too complicated. It is of more use for them to pick out keywords from a text and write them in the margins, to help them remember the text.

Learning is based on the noble art of remembering what is important. It is therefore necessary to develop strategies to forget (not remember) what is not important. It can be at least as important to spend time working out how we can avoid memorizing worthless information.

Sometimes memory enables us to consciously retrieve previously stored facts (*factual memory*) or remember events we have experienced (*episodic memory*). Other memory functions do not require us to be conscious of the memories as we make use of them, e.g. the skills of riding bicycle, swimming, driving a car or writing, which all involve *procedural memory*. Finally, one memory function, the *perceptual memory*, helps us to identify objects in our surroundings. An example of this may be seeing that there is a pencil sticking out from under a book on our desk, or recognizing that a sound outside the classroom is the footsteps of a person walking in the corridor. If the student's perceptual memory is not developed enough, the process of continually identifying objects, sounds and impressions in their surroundings may pre-occupy and overwhelm them. The student will easily become so distracted that their ability to store things in their long-term memory will be adversely affected.

An important everyday skill the ability to "remember to remember". This skill, which encompasses the ability to remember things that have not yet happened, is called *prospective memory*. It requires an awareness of time, as well as good strategies for being able to remember what you have to do. What mainly separates the mindful person from the forgetful one is their choice of effective strategies. It is essential to begin with an awareness of the necessity of strategies to remember things that will need to be done in the future.

Working with Problem Solving

What do we really mean when we say that someone has a good *problem solving ability*? Probably we mean different things according to the context. In the subject of mathematics it is obvious that problem solving ability refers to the skill of solving mathematical problems. Arriving at an answer can be seen as the end point of the problem solving process.

Good problem solving ability usually relies on a procedure characterized by logical thinking, flexibility and a good imagination. It is through the ability to be creative that different alternatives can be assessed, with the help of imagination and reason. When this skill is at its best we feel that we have some sort of control over the problem, and we see different possible solutions.

Common sense thinking is also important in *problem solving*. You can distinguish at least three logical steps in the solution of the problem:

- Identifying the problem
- Creating possible solutions
- Evaluating and selecting the final solution

The first step is to directly identify the problem. It is important that we remain focused, in order to possibly identify other problems, or different angles to the one we first discovered. In mathematics, the problem is often clearly evident from the beginning of a task, but an important step in the solving of the task is to search for other problems. For example, what happens when you change the basis of the problem? How does this change the problem-solving process? Does the answer remain the same?

It is important for the student to practice formulating alternative solutions, even those that at first glance may seem outrageous or stupid. Several alternative solutions should be proposed and compared with each other before the answer is arrived at. This process improves the student's lateral thinking and makes them more flexible. It applies not only in mathematics but also in solving problems arising in day to day life.

Flexibility usually demonstrates that the student is totally capable of that specific task. This provides the mental space for lateral thinking. When teaching students problem solving and lateral thinking, tasks should be of a sufficiently low level that the student could easily manage the problem, i.e. it is an advantage if they have an over-capacity for the task. If the task is too difficult, they will expend too much mental energy, and lateral thinking will be impossible. Students displaying a lack of flexibility usually also have problems with any big changes in their daily routine, and therefore require preparations in advance of such changes.

Working with Logical Thinking

Logical thinking involves the student's ability to make reasonable judgments. To arrive at a reasonable answer to a problem requires that the student has access to their original ideas in thought It is also necessary that they can follow the process step by step from the beginning to the end of the task. Many students who have difficulties with logical thinking need a lot of help with structure and strategies.

They need the instructions as to how to go about the task presented in clear steps so they do not get lost. If the student loses tracks, or gets stuck or the details, they will find it difficult to make a reasonable judgment on sound thinking.

Simplifying the learning material and helping the student to break down tasks into different steps can compensate for lack of logical ability.

Poor logical thinking first becomes evident when the student starts working with more advanced mathematics. The problems are usually obvious when they attempt written math's problems, in which they have to pick out the relevant numbers for the calculations in different stages of the task. It may help the student to read the last part of the text first, so that they have a clear idea of what is being asked. This should enable them to be more focused on the question itself when the remaining part of the text is read.

The foundation for the development of logical thinking lies in the ability to stop and reflect over how you solved a task or problem. The most important questions to consider are: "*What is a reasonable answer? Does my answer agree with this?*

If there is a big difference between the two, what assumptions can we make from this?"

Logic involves both thought and reason. It involves the ability to think in a well-defined sequence in order to reach a solution or goal. When this sequence is clear enough it should be possible to follow the different steps to reach the answer we seek.

Working with Motivation and Blockings

Ideally, motivation should originate from the child itself, through curiosity and a desire to learn. For this motivation to be sustained, the student must have a consistent idea and conviction that they can succeed.

It is not unusual, however, that parents and teachers have to constantly push the student to learn. In these cases the student is driven by an *external motivation*. This may be necessary in the initial stage of the learning process, but in the long run it is insufficient and very unsatisfactory.

It is easy to end up in a battle with a student who is solely driven by external motivation, with seemingly no hope of finding *inner motivation* in the students themselves.

Lack of motivation is common in cases of dyscalculia. The student displays uneven results over a time, from one moment to another or from day to day. They may solve one task but fail with the very next. This drains the student's motivation, and makes it difficult to know if the student's reluctance to learn is grounded in emotional blockings or cognitive difficulties.

Developing motivation requires the students to exercise their own will power. If they have a negative self-image, it is essential to start by improving their confidence and self-esteem.

If a student has the strong conviction that they always fail, it is of utmost importance to challenge this idea with more positive images.

Interest and *curiosity* are essential to inner motivation. In learning, students should spontaneously ask themselves: *What was that? This seems interesting!* Once their curiosity is aroused it is important that a feeling of *competency* follows. It is this feeling on which the student's continuing motivation depends. It cannot be over-emphasize d that the student does **not** develop or learn very much from constant failure. They only learn how to avoid what is difficult and humiliating.

An Overview of Thought, Feeling and Action

We humans interpret what we experience in an intensely personal way. From the viewpoint of *cognitive science* we can see that thoughts are reflected in our emotional life.

The thoughts reflected in emotion will also find expression in our way of acting in different social situations. Ingrained attitudes arise as *automatic thoughts* about things and events in everyday life. They trigger stress reactions such as we see in the student who looks at a new mathematical problem and automatically gets a defensive, negative attitude. They may exclaim: *"I don't know how to do that! I won't do it!"* The automatic thought that might have arisen in this situation is: *"This is one those impossible math's problems! I will certainly fail, and then everyone will see how stupid I really am! Better avoid it altogether so I don't expose myself."*

In the field of learning we must be aware of all negative automatic thoughts, because they only confirm and reinforce failure. They do not only affect only thought patterns but also emotions and behavior. Ideally we should be able to identify **both** our strong and weak sides. We can then openly talk about which help strategies are most needed. All people have a right to succeed.

DYSCALCULIA – TEST

Mathematics Screening (For teachers, psychologists and medical doctors)

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- Takes about 30 minutes
- Easy to handle
- Show you different types of mathematical disabilities

Mathematics Screening has been developed primarily for meeting a need within secondary school education of being able to make certain systematic observations relevant to the teaching of mathematics to pupils who appear to have certain learning difficulties.

Mathematics Screening is designed for use in investigating the difficulties in math that some pupils have that can be traced to difficulties connected with the cognitive processes which mathematical thinking requires. Cognitive difficulties of this sort can affect school achievement both in mathematics and in other subjects.

Assessment of the math performance of pupils on the basis of group tests is often of little value to the teacher in planning either teaching generally or special measures aimed to help, although such tests do provide information on where the individual pupil or an entire class stands generally in relation to pupils of the same age level.

Mathematics Screening is not a traditional, standardized test for which exact norms are available. Instead it has a screening function, *pupils without serious difficulties in math being expected to be able to solve all the tasks.* If a pupil fails to solve one or more of the tasks, this is an observation worthy of note. It should lead to further examination of the functional difficulties the pupil's results on *Mathematics screening* have pointed to.

A thorough evaluation of a pupil's difficulties in math should also include an assessment of reading and writing difficulties. Thus, if *Mathematics Screening* indicates a pupil to have difficulties with mathematics, administering ***Reading Screening*** and ***Writing Screening*** too as a complement to this is to be recommended. A more adequate overall picture of the pupil's difficulties as a whole and of his/her strong points as well can be obtained in this way. This is very useful from an educational standpoint.

More information and order:
www.dyscalculiainfo.org