

The Warnke Method and Difficulties in Learning

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Abstract: In spite of a normal, sometimes high, intelligence many of the children going to school have serious problems in learning some subject connected with engineering education, especially mathematics. Quite often the reason for this are disturbances called dyslexia and dyscalculia and it has been shown that there is a connection between problems in learning and the basic functions concerning time and frequency resolution in hearing, seeing and motor skills. The method of Warnke is one of important tools to diminish those problems. A special four-month-period of training can improve significantly the skills of reading, writing and calculating. The main item of the method are devices called: Brain-Boy Universal Professional, Brain-Boy Universal, Audio-Video-Trainer, Lateral-Trainer Professional. Children can improve seven basic functions by playing special games using the first two devices. Moreover, Audio-Video-Trainer and Lateral-Trainer Professional allows to develop coordination of hemispheres (corpus callosum), which is often impaired in function in case of dyslexia and dyscalculia and thus disturbances in the coordination and synchronization of the functions of the hemispheres arise. Warnke method training can not only improve the central processing of perceptions, but also may cause a significant transfer to reading, writing and calculating skills. The method can be used in general prevention against dyslexia and dyscalculia.

Key-Words: Dyscalculia, dyslexia, Warnke-method, difficulties in learning, low level functions

Introduction

Researchers estimate that each year between 10 and 15 % of the population of children suffer from serious problems in learning even if they have an average or higher intelligence. In most cases these problems concern deficits in reading, writing and calculating. Quite recently it was shown that the reason of these problems are some deficits in the central processing of perceptions and disabilities of automatical work of micro-functions in some areas of brain.

In the last half of the century numerous scientific papers have been published, which contain presumed causes of such problems in reading and writing, called *dyslexia*. In the last years scientists have become convinced that the main cause of dyslexia are temporal processing deficits mainly in hearing, but also in motor skills and seeing (cf. [13]).

The deficits in calculating are causing many difficulties in today's world, which requires us to process unprecedented levels of numerical information. Computers, smartphones, financial and healthcare information processing are just a few of the many contemporary demands requiring our numerical fluency. Despite this landscape, up to 25 % of "economically ac-

tive" individuals in countries such as the United Kingdom remain "functionally innumerate" (see [3, 9]). Such difficulty often called *dyscalculia* was originally defined as a disability in mathematics caused by impairments to particular parts of the brain involved in mathematical cognition, but without a general difficulty in cognitive function. The same definition is being used today by researchers in cognitive neuroscience. For instance the Department for Education and Skills of United Kingdom states the following.

Dyscalculia is a condition that affects the ability to acquire arithmetical skills. Dyscalculic learners may have difficulty understanding simple number concepts, lack an intuitive grasp of numbers, and have problems learning number facts and procedures. Even if they produce a correct answer or use a correct method, they may do so mechanically and without confidence. Very little is known about the prevalence of dyscalculia, its causes, or treatment. Purely dyscalculic learners who have difficulties only with number will have cognitive and language abilities in the normal range, and may excel in non-mathematical subjects. It is more likely that difficulties with numeracy accompany the language difficulties of dyslexia.

While the British Dyslexia Association describes dyscalculia as follows.

Dyscalculia is a learning difficulty involving the most basic aspect of arithmetical skills. The difficulty lies in the reception, comprehension or production of quantitative and spatial information. Students with dyscalculia may have difficulty in understanding simple number concepts, lack an intuitive grasp of numbers and have difficulties learning number facts and procedures. These can relate to basic concepts such as telling the time, calculating prices, handling change, estimating and measuring such things as temperature and speed. (<http://www.bda-dyslexia.org.uk>)

While many factors such as educational experience, IQ and other cognitive abilities, and motivation may undermine the development of numeracy skills, one key potential impediment is a developmental learning disorder that is specific to numeracy. *Developmental dyscalculia* (DD) is such a learning disorder that specifically affects the ability to acquire school-level arithmetic skills (see [9]). Traditionally, the defining features of DD have been poor retrieval of arithmetic facts from memory and the perseverant use of immature calculation strategies (see [1]).

The percentage of the population with DD is estimated to be 3-6 percent (approximately one in twenty individuals), which is similar to that for dyslexia. Unlike some other learning disabilities, dyscalculia is as likely to affect girls as boys. Despite the evident importance of numerical and mathematical skills for life success and a prevalence rate equivalent to that of developmental dyslexia DD has been chronically understudied, with studies on dyslexia outnumbering those on DD by 14:1 as recently as 2007. The consequence of this under-attention is that the cognitive causes of DD are currently poorly understood (cf. [2, 9, 14]).

Besides developmental dyscalculia, some other types of dyscalculia have been distinguished like for example acquired dyscalculia (cf. [12]).

It seems that there are many possible causes for dyscalculia, also genetic and environmental, and various interactions of them. The cause for one person may not be the same as for another, and in many cases it may be not so obvious.

Dyscalculia often co-occurs (is comorbid) with other learning difficulties such as various types of dyslexia, dyspraxia, specific language impairment (SLI), spatial difficulties (not good at drawing, visualization, remembering arrangements of objects, understanding time/direction) and Attention Deficit Hyperactivity Disorder (ADHD). This is probably because both environmental and genetic factors, affecting brain development, may act on several areas of the

brain at once (see [13]).

The educational researchers have noticed, in particular, the following difficulties in learning in primary school (see [11]).

1. Delay in counting.
2. Delay in using counting strategies for addition.

3. Problems with memorizing arithmetic facts, memorizing simple addition, subtraction and multiplication facts. These symptoms may be caused by the subsequent two more fundamental difficulties (although more research is needed to be sure):

a) lack of "number sense" (dyscalculic children may have a fundamental difficulty in understanding quantity);

b) less automatic processing of written numbers (dyscalculic children may have difficulty in linking written or spoken numbers to the idea of quantity).

There are several other symptoms, which have not yet been studied in detail by researchers. In particular, the subsequent have been reported by teachers or workers in special education (see [11]).

1. Difficulty in imagining mentally a number line.
2. Particular difficulty with subtraction.
3. Difficulty in using finger counting (slow, inaccurate, unable to immediately recognize finger configurations).
4. Difficulty in decomposition of numbers (e.g., recognizing that 10 is made up of 4 and 6).
5. Difficulty in understanding that the value depends on a position of a digit.
6. Troubles in learning and understanding reasoning methods and multi-step calculation procedures.

Warnke Method

The human brain has a specific property, called ability to change (plasticity) and it is most plastic during childhood; but also shows much plasticity in adulthood (cf. [7]). So, even though dyscalculia is related to brain functioning, there is no reason why that function cannot be changed. It could be changed by experiences at home (an environment which encourages attention to number), by teaching in school, and by intervention programs. Intervention programs are particularly promising for the severe learning disabilities. We know from research on dyslexia that auditory training programs can result in significant improvement in reading, which is associated with some changes in brain function (see [8]).

Fred Warnke, a communication-expert, developed around ten years ago a method that allows to identify and train those deficits. It is based on the fact that children suffering from such problems were unable in their early years to memorize the sound patterns of the words they heard. As they do not know what the sound of a word is like, they do not know what (letters) it consists of (see [17]).

The lowest of five stages of language competence have been named *low level functions* by M. Ptók [10], the head of the department of phoniatry and pedaudiology at the Medical University of Hanover. They consist of different capabilities such as pitch discrimination, spatial hearing, time decoding of speech, recognizing of frequency patterns and auditory reaction time. Although they do not influence directly child's command of language, they build the basis for learning it. It seems that there is a clear correlation between a weak phonological awareness and malfunctions in basic processing functions of auditory perception in early years of age. This shows how the low-level functions are important for language learning processes and suggests that if they are insufficiently developed, then weaknesses in reading and writing can be a result.

Such conclusions has been justified by investigations of U. Tewes (Medical University of Hanover), who started in 2001 a standardization project and obtained data of seven low-level functions from 382 children of age 5–12 years within four disseminations. The norm date was developed from those results and compared with the ones of 28 dyslexic children and highly significant differences have been found. Next, S. Michalski and Tewes made a training-study with 51 dyslexic and a parallel group of 41 children. The highly significant improvement results were obtained after five weeks of the Warnke method training.

After that Tewes was asked by the Ministry of Education of Thuringia to supervise another study in three primary schools. During this study the progress after four months of training was compared of three groups of dyslexics with different training measures. The results were following: All children of the three groups attended the usual lessons at school in the morning. Group A got extra lessons in reading and writing (traditional remedial training). The spelling skills improved by 6,3 %. Group B did training of the seven low-level functions. The members of this group improved their spelling by 18,9 %. Group C did low-level- and lateral-training. Here the improvement of spelling reached 42,6 % (see [16]).

The Warnke method makes it possible to check and train fourteen functions quickly and in a playful

atmosphere. It can be done when testing the central processing of perceptions in order to check as many functions as possible in a short time. It is very important to measure to what extent those functions are automated and to avoid mistakes caused by wrong answers of an exhausted child. Afterwards the results are checked against standardized data of other children to find out if there are deviations or even clear malfunctions (see [17]).

Now, we shortly describe the three foundationstones on which the method, developed by Fred Warnke, is based on.

1) The first one is **automation of the processing of perceptions in hearing, seeing and motor skills**. The basic pre-conditions for learning the processing of perceptions must be well developed. The speed of processing must be improved and automated. The small electronic device called Brain-Boy Universal is helpful in such therapy of deficits in hearing, seeing and motor skills. It contains seven training programs resembling games, which enhance seven basic functions of perception and their processing. Only few months training is sufficient for a significant improvement (see [8, 12, 16]).

2) The second is **automation of the coordination of the brain-hemispheres**. During the process of learning how to read and write the two "halves" (= hemispheres) of the human brain must work closely together. The coordination between the hemispheres is done by the corpus callosum, a nerve cord that forms the connection. In most cases of dyslexia this nerve cord is suspected not to work properly. In order to improve the function of the corpus callosum, Fred Warnke has developed a special training called "Lateral Training". During this training, the child hears a model voice (from a CD) on one side of his headphones and hears his/her own voice speaking in synchrony on the other. A special electronic device makes the voices wander between the two sides. Thus the child's perception must always be aware from where he/she has heard which voice. A regular lateral training causes a better synchronization of the two hemispheres by activating existing but inactive nerve fascicles in a comparatively short time (see [5, 12, 17]).

3) The third is **development and automation of a visual dictionary**. As mentioned before, children who have difficulties in reading and writing often have only a vague idea of how a word is spelt. It can be improved by a training called "visual spelling". This training helps the child to find ways to memorize the spelling of all those words the pronunciation of which differs much from the spelling. A very efficient help in this training is the PC-software Orthofix (see [6, 17]).

We could expect that somewhat similar effects might occur in the case of dyscalculia, though it seems that no methodical research results in this area have been published so far.

Diagnosis and therapy procedures

The tests are one of the most important parts of the Warnke method and a large number of qualified experts have validated them for several years to obtain a basis for further training. There are fourteen steps of the playfully designed testing procedure (of around one hour), which is to find abilities and chances for further training (and not to find things the child is not capable of). They are listed below to guide through the test procedure for which, of course, some test devices are necessary (cf. [19, 15]).

Steps Details

1. *Visual Order Threshold*. Two light-flashes are produced. The person practising is asked to identify on which side he/she saw the first. The level of difficulty is steadily increasing (Interval-Range: 5-800 ms).

2. *Auditory Order Threshold*. Two tones are produced. The child hears two clicks through headphones; one click from each side and it must find out which click was the first one, while the level of difficulty is steadily increasing (Interval-Range: 5-800 ms).

3. *Spatial Hearing*. The direction of a click that seems to come from a point near the middle of the head must be identified (range 20-800 ms). This is for training of spatial hearing.

4. *Pitch Discrimination*. Two sounds of different pitch are produced. The person practising must recognize their difference and order.

5. *Auditory Motor Coordination – Finger-Tapping*. In this programme, the user must press buttons according to clicks he hears in his headphones coming from two sides alternately. It must press two buttons in synchrony with the clicks. If it is done correctly, the speed increases (range 160-900 ms).

6. *Choice-Reaction Time*. It is a combination of pitch discrimination and reaction. Here the user must identify the difference of the two tones given, know where they came from and name them as quickly as possible. For instance, must find out as quickly as possible on which side the deeper tone was.

7. *Frequency Pattern Test*. This programme produces three tones one of which is different and must be recognized. In case of success, the duration of the

tones and the interval in between are shortened (range 10-800 ms).

7a. *Duration Pattern Test*. This programme produces three tones one of which is longer and must be recognized. In case of success, the duration of the tones is shortened (range 10-800 ms).

8. *Coordinative Skills*. The child is asked to balance a light wooden rod (1 m long) on the back of his/her hand.

9. *Reading Meaningless Texts*. To find out which strategy the child uses for reading he/she is asked to read a meaningless text aloud. The number of mistakes and the time used show the method of reading the child has adapted so far. That issue can be somewhat explained by the following story (see [18]) of ... *a 16 years old boy who, with a very high IQ of 150, showed extreme low-level deficits. The following mutilated sentence was told to him: "The Ørice of the Ørees is in my Øook." The Ø represented an invented sound that helped to reproduce his inadequate sound discrimination. His parents who were standing alongside looked uncomprehending. Yet he answered immediately: "That only can mean "The price of the trees is in my book". Everything else wouldn't make any sense." Everything else - these are 214 possibilities that could be additionally created from this unclear sentence! The student had the ability to compensate for his inadequate automatic sound recognition for years by using the sense of the words and sentences.*

10. *Short Time Memory*. The child hears words consisting of two-three-four-five-six meaningless syllables and is asked to repeat the syllables every time.

11. *Perception Discrimination*. The child is to repeat meaningless words in order to find out his/her ability to discriminate (plosive) consonants. The recording simulates the atmosphere and acoustic conditions of a classroom.

12. *Dynamic Vision*. The child must follow a moving finger, describing a horizontal figure-eight pattern with his/her eyes without moving the head.

13. *Angular Ametropia*. This step tests if the child's eyes are able to focus the same spot. This deficit often leads to serious difficulties in reading from the blackboard in class.

14. *Visual Spelling*. The child is asked to write words "into the air" to find out if it has developed inner representations of spelling. In addition to this the software "Orthofix" can be used in case the child needs training in automating visual spelling.

Depending on the results the amount of training necessary is estimated and possibly combined with other pedagogical actions already taking place. The

training is based on steps listed above and we have to use the following devices for this training: Brain-Boy Universal Professional, Brain-Boy Universal, Audio-Video-Trainer, and Lateral-Trainer Professional.

Below we provide a short description of those devices according to [19].

Description of the devices and their applications

The Brain-Boy Universal Professional (BUP) can be used for testing and training of the following low-level functions: visual and auditory order threshold, spatial hearing, pitch discrimination, visual and auditory motor-timing, choice reaction time, frequency pattern recognition, duration of tones recognition. The efficiency of the training has been proved by a scientific study carried out by the Medical University of Hanover. The tests of the BUP (run in the so-called Normtest-Mode) are identical to those of the Brain-Boy Universal (BBU) so that results from the BUP can be directly compared with the standardized data once ascertained with the BBU. Therefore the therapist can check child's progress with his BUP each week although the child is working with a BBU. Doing this, the therapist always gets the percentile rank the child has reached in each of the eight functions. Let us mention that there are different percentile rank lists available for children between 5 and 12 years. These ranks were investigated during a standardization project in cooperation with the Medical University of Hanover. In this way the BUP is a professional device working on the basis of scientifically standardized data that enables the therapist to get valid and true information when testing basic central functions. Apart from testing, the BUP allows various ways of training. In particular it offers features specially designed for each low-level function, such as:

- volume-adjustment of earphones from 72 dB to 110dB;
- show/don't show visual confirmation;
- repetition of the last signal/task;
- choice of signal-mode: click or noise-burst;
- logarithmic approximation - determination of the approximate order threshold with max. 40 signals;
- successive approximation - quick determination of the current order threshold avoiding effects of fatigue;
- randomized order - randomized intervals between userdefined maximum and minimum.

The handling is very comfortable. Most tests can be done by using only two big push-buttons. The shipping includes two external buttons - they consist of wooden balls with built-in buttons. The BUP can not only measure basic functions but also can store all data of patients and tests on a compact-flash card. All data that were recorded during the day can be transferred to the PC-software MediTOOLS. The interface between the BUP and the MediTOOLS-software has been enhanced. It offers a possibility - for example - to design training-setups with a computer and copy them to the BUP to have them available there. With the help of MediTOOLS one can not only record all results of the test procedure quite easily but generate complete reports automatically for parents, practitioners and other therapists.

Brain-Boy Universal (BBU) - A Multifunctional Device. A well-working central processing consists of many functions in different parts of the brain such as: Order Threshold (visual & auditory), Spatial Hearing, Pattern Recognition, Pitch Discrimination, Auditory Motor Coordination, Choice Reaction Time. With its seven different game programs, the Brain-Boy Universal offers an easy, effective and scientifically proven way to enhance the functions of central hearing. Each program can be started at different levels to make it suitable either for beginners or experts. A simple menu-system guides through all functions, you only have to use two of the three buttons of the BBU for navigation. Moreover, there are two manuals: a special one for children and one for adults. There is yet another special feature in the BBU: in case of a correct answer the BBU praises per voice output and increases the difficulty. Thus, the user gets an immediate and motivating feedback. If the BBU is used by older children or adults the voice output can be switched off.

Audio-Video-Trainer (ATVT (Home-Trainer)). The Lateral-Training can be divided into three main steps. First, the person practising listens to a story or a song in lateralized mode coming by headphones. After that the user reads the text himself and hears his own voice in lateralized mode via headphones. Finally the user tries to read in synchrony with the one on the CD. He hears both voices lateralized in his headphones. This step can be supported by the special glasses which darkens the right and left glass in turns. It is possible to make both glasses transparent for a short interval. The most important features of the AVT are: input socket for two microphones, Socket to operate the special glasses (mentioned above), built-in special consonant enhancement, built-in noise generator, mono/stereo mode (suitable for dummy-head-recordings).

Lateral-Trainer Professional (LTP). It was developed for professional users and many useful features (e.g., a lot of setting facilities) offer a wide range of application for numerous eventualities. The basic difference between the home-trainer and this professional device are the far more precise setting facilities of the latter. One can, for example, set the hold-intervals of auditory and visual lateralization for each ear or eye with an accuracy of 0.2 s within a wide range. LTP is highly applicable for group-work because there is the opportunity to connect an additional headphone-distributor with integrated amplifier. This component makes it possible to work with up to seven headphones. Using two headphone distributors, one can even work with twelve headphones on one LTP.

The lateral training of central automation and coordination of the hemispheres has become an important part of the Warnke method in program to improve automatic perception and processing. In most cases, malfunctions in language development could be reduced or completely eliminated which led to a clear improvement in reading, writing and calculating. How does Lateral-Training work? The constant change of direction of two different voices that seem to walk around the head forms the main principle of the Lateral Training. Working with this technique is a demanding training that stimulates the coordination of the brain-hemispheres to a high degree. Particularly the hearing and processing of two voices at the same time coming in from two different channels have proven to enhance the function of the "communication line" between the hemispheres, the corpus callosum. After some training units you may include the special glasses, exercises for motor skills (with the wobbling board, for example) or other implements to your training-scheme. All these are important supplements of the Lateral Training (cf. [19]).

Beside the standard version, the LTP is also available with a built-in sound discrimination trainer (DT). All functions of the standard version can be used with this additional part, too. The DT can produce eight different meaningless words ("ETI", "EFI", "EKI" and so on), the order of which is randomized. The patient must identify the consonant in the middle and - dependent on age and capability - can either answer by pressing a button himself or repeat the word aloud. In this case, the therapist presses the answer buttons according to what the patient has told him.

The special merits of the LTP are:

- start right out of the box - pre-settings allow a quick and easy start,
- mono/stereo mode,
- white noise to be added in steps of 2 dB (from

-30 dB to 0 dB),

- accurate setting for each function with the help of a numeric display,
- display of visual and auditory lateral position,
- "Stop lateralization" - button,
- two microphone sockets,
- adjustable lateral width,
- suitable for dummy-head recorded CDs,
- consonant enhancement facility (according to Warnke).

Only the Lateral-Trainers are equipped by default with a consonant enhancement, which enhances those parts of spoken language that are important for understanding certain frequencies and critical consonants (see [19]).

Conclusion

The Warnke method is very efficient in diagnostics and improvement of the ability of learning of children with some difficulties in it. It has proved to be quite successful with regard to dyslexia. But it seems that it could help also in dyscalculia problems (at least to some extent), because of some similarity of reasons of them. Unfortunately that latter issue is still understudied and a systematic research would be desirable in this area.

References:

- [1] D.C. Geary and M.K. Hoard, Learning disabilities in arithmetic and mathematics. In: *Handbook of Mathematical Cognition*, New York: Psychology Press, 2005, pp. 253–267.
- [2] R. Gersten, B. Clarke, and M.M.M. Mazzocco, Historical and contemporary perspectives on mathematical learning disabilities, In: *Why Is Math So Hard for Some Children?*, Brookes Publishing, 2007.
- [3] J. Gross, C. Hudson and D. Price, The Long Term Costs of Numeracy Difficulties, *Every Child a Chance Trust and KPMG*, 2009.
- [4] G. Hesse et al., Die stationäre Intensivtherapie bei auditiven Verarbeitungs- und Wahrnehmungsstörungen im Kindesalter, *HNO* 49 (8), 2001, pp. 636–641.
- [5] G.W. Hynd et al., Dyslexia and Corpus Callosum Morphology, *Arch. Neurol.* 52, 1995, pp. 32–38.

- [6] P.W. Jusczyk, E.A. Hohne, Infants' Memory for Spoken Words, *Science* 277, 1997, pp. 1984–6.
- [7] T. Kujala et al., Plastic neural changes and reading improvement caused by audiovisual training in reading impaired children, *Proc. Nat. Acad. Scien.* 98 (18), 2001, pp. 10509–514.
- [8] S. Michalski and U. Tewes, Zentrale Hörstörungen nachweislich trainierbar, *Hörakustik* 10, 2001, pp. 98–106.
- [9] G.R. Price and D. Ansari, Dyscalculia: Characteristics, Causes, and Treatments, *Numeracy* 6 (1), 2013, Art. 2.
- [10] M. Ptok, Auditive Verarbeitungs- und Wahrnehmungsstörungen und Legasthenie, *Hess. Ärzteblatt* 2, 2000, pp. 52–54.
- [11] L. Rousselle and M.-P. Noel, Basic numerical skills in children with mathematics learning disabilities: A comparison of symbolic vs non-symbolic number magnitude processing, *Cognition* 102, 2007, pp. 361–395.
- [12] O. Rubinsten and A. Henik, Automatic Activation of Internal Magnitudes: A Study of Developmental Dyscalculia, *Neuropsychology* 19, 2005, pp. 641.
- [13] O. Rubinsten and A. Henik, Double Dissociation of Functions in Developmental Dyslexia and Dyscalculia, *J. Educat. Psychol.* 98, 2006, pp. 854–867.
- [14] R.S. Shalev, J. Auerbach, O. Manor, and V. Gross-Tsur, Developmental dyscalculia: Prevalence and prognosis, *Eur. Child Adolesc. Psychiatry* 9, Suppl. 2, 2000 (Jan.), pp. 58–64.
- [15] Success in Learning by Improving Automation: Warnke-Method, MediTECH Electronic GmbH, http://www.meditech.biz/uploads/media/S023-uk-Success_in_learning_kompress.pdf.
- [16] P. Tallal, Temporal Processing in the Nervous System - Special Reference to Dyslexia and Dysphasia, *Annals of the New York Academy of Sciences* 682, 1993, 439 pp.
- [17] F. Warnke, *Was Hänschen nicht hört ...*, VAK-Verlag Freiburg, 2001.
- [18] F. Warnke and H. Hanser, Goodbye Private Lessons, *Gehirn und Geist* 1, 2004, pp. 1–6 (in German; English version: *Gehirn und Geist*, issue 1/2006).
- [19] Warnke-Method, Catalogue 2007, MediTECH Electronic GmbH, <http://meditech.biz/fileadmin/download/English/S034-uk-MT-Catalogue>.