

Selected intervention methods for the memory and attention development in students with specific learning disabilities: a case-control study

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Abstract: *The presented results focus on selected intervention methods aimed at memory and attention development in students with specific learning disabilities. The research sample consisted of 30 pupils aged 9.1–10.0 years. This age range corresponds to the 3rd and 4th years of elementary school. The respondents were selected based on stratified sampling. The group was intentionally divided into experimental and control groups of 15 students each. The common denominator was the general diagnosis of moderately severe learning disability (according to ICD-10; specific developmental disorders of scholastic skills) for all pupils. We applied diagnostic tools focused on memory and attention to evaluate the effect of the intervention. These were mainly the Learning Memory Test, the Path Test and the Attention Concentration Test. The intervention in the form of individual therapy lasted from September 2021 to January 2022 and it took place 2 times per week for the duration of 30 minutes. The presented results point to a positive impact of the intervention in the experimental group.*

Keywords: *specific developmental disabilities, memory and attention development, special education intervention, education and development of pupils, learning disabilities*

1 Introduction

From a general perspective, neurodevelopmental disorders are considered to be complex conditions. Albeit the conceptualization of these conditions is not easy. The term itself has been used for a broad group of disabilities that includes a form of brain development disruption, thus, constituting a wide range of neurological and psychiatric diseases. From a clinical point of view, these conditions are quite different in terms of their causes e.g., rare genetic syndromes, cerebral palsy in children,

congenital cerebral palsy, congenital anomalies, autism, attention and movement disorders, mental disorders, hyperactivity (ADHD) or others (Rutter et al., 2006; Thapar & Rutter, 2017). A key characteristic of neurodevelopmental disorders is that they quite often start typically in childhood before puberty. It is also necessary to distinguish them (based on the clinical picture) from many neuropsychiatric disorders. Even though the course of these disorders is subject to maturational changes, there are disorders such as ADHD, autism, learning disabilities or mental disabilities that show a constant course. Thus, remittent or relapsing patterns cannot be observed. Such patterns are then typical, for example, in schizophrenia or mood disorders (Rutter et al., 2003; Lichtenstein et al., 2010; Thapar et al., 2017).

Neurodevelopmental disorders can be characterized as a kind of inability to reach cognitive, emotional, and motor developmental milestones. Such disorders are thus closely connected with the disruption of coordinated events that are necessary for the development of the brain itself. The disorders can thus become a relatively socially significant health problem that is estimated to affect >3% of children worldwide (Gilissen et al., 2014). Experts also talk about a heterogeneous etiology that leads to the impairment of cognitive, communication, adaptation, and psychomotor functions.

Therefore, the comorbidity of two or more disorders can be commonly observed (van Bokhoven, 2011; Parenti et al., 2020). Different neurodevelopmental disorders may share similar cognitive and behavioural processes, hence they often overlap (in addition to the above mentioned, for example, also with mental disorders) and thus justifying the dimensional approach to the classification of disorders. An acronym ASSENCE (early symptomatic syndromes eliciting neurodevelopmental clinical examinations) was introduced with the aim to point out the amount of overlap between the given disorders and the similarity of their symptoms regarding the patient's younger age (Carlsoon et al., 2013). In the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders), these disorders are defined as a group of conditions with a developmental onset which produces deficits causing functional impairment. In the English version of ICD-11, which is already in force, neurodevelopmental disorders do not differ significantly from the DSM-5 classification. From a professional point of view, it is also possible to say, that the validity of these disorders is supported by a high degree of comorbidity between different disorders. Several studies mention that 22–83% of children with autism spectrum disorder suffer from symptoms that meet the criteria for ADHD. The opposite can be the case when 30–65% of children with ADHD have clinically significant symptoms of autism spectrum disorder (American Psychiatry Association, 2013; Treffer, 2006; D'Souza & Karmiloff-Smith, 2017; Morris-Rosendahl et al., 2022).

It is relatively rare for a neurodevelopmental disorder to occur on its own. Dysfunction in one area quite often accompanies dysfunction in other areas. This

logically leads to multiple disorders. These disorders can be the manifestation of connectopathies, synaptopathy, dendritopathies or disorders of neurotransmission and intracellular signalling, or neurodegeneration. However, it is still not entirely clear how these biological mechanisms cause behavioural dysfunctions or whether they trigger the downstream changes that lead to these behavioural changes (Reiresen, 2017; Ismail & Shapiro, 2019).

1.1 Specific learning disability in the Czech Republic

The term specific learning disability (SLD) can be encountered for the first time when children start to attend school and they might encounter characteristic difficulties in schoolwork. Most often, the children have problems remembering the shape of letters, combining them into syllables and reading them. Their writing tends to be clumsy and with many mistakes. The children may also have difficulties with concentration, and it is very difficult for them to remember new knowledge and learn the subject matter. SLD not only affects the areas of skills that children use and need in school, but also extracurricular activities. The 1980 definition of specific learning disabilities comes from a group of experts at the National Institutes of Health in Washington: "Learning disabilities are a collective term for a diverse group of disorders that manifest as distinct difficulties in acquiring and using skills such as speaking, understanding spoken language, reading, writing, mathematical reasoning or counting. These disorders are specific to the affected individual and assume dysfunction of the central nervous system." (Zelinková, 2003). There is considerable terminological inconsistency in the field of specific learning disabilities.

In the Czech professional literature, we can find various terms e.g., specific learning disorders, specific developmental learning disorders, learning disorders, specific developmental disorders of scholastic skills, the impairment of the graphic side of speech (Pokorná, 2001; Šturma cit. according to Říčan, Krejčířová, et al. 2006; Vitásková, 2005; Zelinková, 2003). All these terms are superior to individual types of specific learning disabilities. The adjective *specific* in professional literature signals that it is necessary to distinguish specific learning disabilities from non-specific ones (so-called pseudo or false learning disabilities), which can be caused, for example, by an insufficiently stimulating social environment or mental retardation (Matějček, 1993; Mertin & Kucharská, 2007). The adjective *developmental* expresses that these disorders are always manifested at a certain stage of an individual's *development* and have a continuous character i.e., their image changes during a child's development (Matějček & Vágnerová 2004).

The SLD includes dyslexia – a specific disorder affecting the area of reading, dysgraphia – a specific disorder affecting the area of writing, dysorthography – a specific disorder affecting the area of spelling, dyscalculia – a specific disorder affecting counting, dyspraxia – a specific disorder affecting motor activities, the Czech specific

is dysmusia and dyspnea. It is therefore evident that a deficit concept of SLD prevails in the traditional understanding of SLD. In line with that, the nature of care for individuals with SLD usually focuses mainly on the direct removal of the presumed cause found in the deficit perceptual-cognitive functions (Michalová & Pešatová, 2011). However, terminological inconsistency is not only the case in Czech terminology. It can be explained by the diverse symptomatology of the mentioned disorders, including various conceptual and theoretical starting points, from which individual groups of experts based their focus (Michalová & Pešatová, 2011).

In American literature, the term *learning disabilities* is used to denote specific learning disabilities, it is generally translated as learning disabilities that do not apply to individuals with mental disabilities, at the same time the term *dyslexia* also appears (Pokorná 2001, p. 53). The use of the term *specific learning difficulties* prevails in Great Britain while in France they prefer to use the typical term *dyslexia*. German professional literature uses the terms *Legasthenia* and *Calcülasteria*. We often come across the terms *spezifische Entwicklungsstörungen*, *Spezielle Lernprobleme*, *Teilleistungschwächen* (Bartoňová, 2006). The professional term *Lernbehinderte* must be distinguished from the previously mentioned since the 1970s in Germany it has been associated with learning problems in individuals who, based on their current mental abilities, fall into the so-called borderline zone or even into the zone of mild mental retardation (Grohnfeldt, 2004).

From a medical point of view, the term specific developmental disorders of scholastic skills (F81), embedded in the 10th revision of the International Statistical Classification of Diseases and Associated Health Problems, cannot be neglected. It is a part of the Disorders of Mental Development section under alphanumeric codes F80–F89. Experts rank there also a specific reading disorder (F81.0), which is relatively broadly defined and includes developmental dyslexia, a specific writing and pronunciation disorder (F81.1), a specific calculation disorder (F81.2) and a mixed scholastic ability disorder (F81.3). In addition, another developmental disorder of school skills (F81.8) and developmental disorder of school skills, unspecified (F81.9) rank in ICD-10 (ICD-10, 2023).

2 Materials and Methods

2.1 The Study

Thirty selected probands who matched the relevant characteristics that fulfilled the selection criteria took part in the research investigation. We carried out a stratified selection of probands with the subsequent informed consent of their legal representatives. Based on the stratified selection, we selected an almost equal proportion of probands, namely 46.7% girls (14 girls aged 9.0–10.0 years) and 53.3% boys (16 boys

aged 9.0–10.0 years). The age range corresponds to the 3rd and 4th grades of elementary school, i.e., primary school. The given thirty probands were randomly selected into an experimental group and a control group. The experimental group participated in the intervention chosen by us. This intervention expanded the existing activities that were implemented with pupils with SEN as a part of the educational process. The division of the probands into experimental and control groups, together with the identified difficulties resulting from the recommendations of a counselling office, is illustrated in Table 1. A general diagnosis of SLD of the moderate learning disability type was established for all probands based on the pupils' records which we received.

The nature of cognitive stimulation was often carried out by filling in worksheets i.e., using paper and a pencil (exceptionally markers or crayons). The nature of cognitive stimulation was often carried out by filling in worksheets i.e., using paper and a pencil (exceptionally markers or crayons) even though, digital technologies are already used more often in schools and are becoming an integral part not only of everyday life, but also of the educational process. However, the worksheets we used targeted all areas of cognition. The worksheets we used targeted all areas of cognition. That is, with regard to the development of orientation, and imagination, including mathematical, as well as memory, attention and optical differentiation, which is no less important in the educational process. Furthermore, reading comprehension, which is also very important for the learning process itself. The selected worksheets were created for the subject of special pedagogical care (in the intervention we used, for example, *Practice memory*, Rezková, 2014; *The concentration of attention*, Rezková, 2013; *Spatial orientation*, Bednářová, 2004). The worksheets are used when working with pupils with attention deficit disorder or pupils with SLD. However, they can also be used as a motivational activity in regular teaching.

The chosen worksheets were selected from complete sets in such a way as to fulfil the justification of the ongoing intervention. The nature of the chosen selection was the time-limited reserved period of the ongoing intervention. Therefore, it was not possible to work with the probands on each of these sets as a whole. Pupils of the experimental and control groups underwent the testing itself using a standardized test (Learning Memory Test). Concerning the focus of the research investigation, we formulated the following causal research problem: How does a special educational intervention affect changes in the level of memory and attention in the monitored probands? Concerning the research problem, we also set a research goal: To find out how the chosen special educational intervention influences the memory and attention of the probands of the experimental group in comparison with the control group.

Table 1: *The diagnosis of SLD and the level of supportive measures (SM) in the experimental and control groups (source: authors)*

PROBAND	SM	PROBANDS' DIFFICULTIES IMPLIED BY RECOMMENDATIONS
E1	2.	dyslexia, dysgraphia
E2	2.	dyslexia, dysortography
E3	2.	dysgraphia, dysortography, mild behavioural disorder
E4	2.	dyslexia, slow work pace
E5	3.	Moderately binding SLD (dyslexia, dysgraphia, dysortography), mild behavioural disorder
E6	2.	dyslexia, dysgraphia, dysortography, attention disorder
E7	2.	dyslexia, dysgraphia, dysortography
E8	2.	attention disorder (ADHD), higher emotional irritability, slightly increased impulsivity, mild dyslexia, dysortography
E9	2.	dysgraphia, dysortography, dyspraxia
E10	2.	dyslexia, slower working pace, lower short-term memory
E11	2.	dyslexia, dysortography
E12	2.	dyslexia, dysortography, attention deficit disorder (ADHD)
E13	3.	behavioural disorder, dyslexia, dysgraphia, dysortography
E14	2.	dyslexia, dysortography, dysgraphia
E15	2.	dyslexia, dysortography
K1	2.	attention deficit disorder (ADHD), dyslexia
K2	2.	dyslexia, dysortography, mild behavioural disorder
K3	2.	dyslexia, dysgraphia, dysortography, moderate behavioural disorder
K4	2.	dyslexia
K5	2.	dysgraphia, dysortography, dyspraxia
K6	2.	dyslexia, dysortography, slow working pace
K7	2.	dyslexia, dysortography
K8	2.	activity and attention disorder, dyslexia, mild dysgraphia, dysortography
K9	2.	dyslexia, dysgraphia, dysortography,
K10	3.	dysgraphia, dysortography, emotional instability, low level of self-control, attention disorder (ADHD)
K11	3.	dyslexia, dysortography, dyspraxia, mild behavioural disorder
K12	2.	dyslexia, dysortography, mild behavioural disorder
K13	2.	dyslexia, attention and activity disorder
K14	2.	dyslexia, dyscalculia
K15	2.	dyslexia, dysortography, higher emotional irritability, higher fatigue

2.2 Intervention

The testing itself was carried out in two phases, for both groups always with the same time interval of 12 weeks. The proband always worked individually with the worksheet according to his/her pace. A personal computer or a tablet computer was used for motivational games or exercises individually as well. If the nature of the game or exercise (in a tablet computer) required group work, the probands worked sometimes in groups. The same was applied to working with a smartboard. We used group work as a motivational supplement. The use of digital technologies is becoming more a part of everyday school life and a matter of course. Therefore, we considered it important to include this activity in the intervention. We found working with modern technologies suitable for the probands especially when they could scan a QR code that redirected them to a self-study activity e.g., in the form of a motivational game – for attention.

Work in the form of ordinary pencil filling is no longer attractive for today's generation of schoolchildren. Despite the purpose of the research i.e., the development of memory and attention, it is appropriate to assess the intervention – stimulation with a comprehensive (multisensory) approach. It is therefore important to include the development of communication skills as well. The development of communication skills is one of the basic competencies of a person. Competence is necessary for communication with the environment, a person needs it almost constantly. Understanding and communication skills are developed through experiences, and on that account, we chose not only so-called feedback on the intervention but also interaction on a social level. Thus, we chose the following methods: direct questioning before starting the work, the mutual interaction of the probands with each other regarding the understanding of the assignment, and a discussion to find appropriate procedures as well as the discussion of the final elaboration of a given task.

Individual needs of all probands in both the experimental and the control group were respected. Some of the pupils (in terms of their diagnosis) suffered from lower understanding and uncertainty and needed more reassurance that they were progressing in the right direction in their individual work. They needed to sort out their insecurities and so they were given the support they needed. The subsequent discussion after the intervention took always place according to the needs of the participants and without a time limit. Most often, the discussion related to the difficulty of a task and chosen strategies for completing tasks. The pupils were for example willing to share the chosen procedure with each other and advise others on how to make the work easier. Within the framework of the principles of special pedagogy, we acted concerning the personal needs of individuals i.e., they could choose from a certain range of sheets (from the easiest to a more complex one) which sheet they wished to work on. If the nature of the exercise did not require a time limit, the individual always completed it according to his/her own work pace.

2.3 Assessment

To monitor the impact of our intervention, we used the **Learning Memory Test**, which was a follow-up to the original Auditory-Verbal Learning Test (AVLT, according to the author Rey RAVLT). A translated version published in 1998 has been used in the Czech Republic (Preiss, 1998). The test was last updated in 2013 and it is suitable for the age category 9–14 years, including adults.

The given test classifies short-term and long-term memory. In an individual, it reveals deficiencies in the capacity and quality of receiving, retaining and subsequently processing information through auditory-verbal means (Hrbáčková, 2020). Individuals are evaluated individually according to the methodology of the given test. Moreover, it can be modified into a verbal-graphic form for a group of probands at once. Nonetheless, it is necessary to consider the distortion of the resulting values because of the visually graphic form of the word thanks to which the tested proband can remember the dictated word the next time it is repeated. However, it depends on the individual dispositions of each person. The given test is described as culture-free.

Each country uses its own set of words, which are 2×5 , the test contains two sets (basic and substitute = retest).

Set A is the main one and is dictated to the test subject 5 times in a row (A1–5). The proband is to name as many words as possible, regardless of the order. Subsequently, set B is dictated to the test subject once. Then we ask the proband to immediately recall set A again (A6). We test the last equipment of the set of words with a time interval of 25–30 minutes (A7). The spare set serves in case a retest is necessary. Unlike the previous test, this one is more demanding in terms of time and administration. If we do not want to expose the proband to a stressful situation, it is necessary to reserve enough time. If the individual does not remember a certain word, it is necessary to assure him/her that it is not a problem and encourage him/her to cooperate further. A recording sheet is used for evaluation. The total is calculated as the number of words covered during the 5 times dictated set. It is also possible to roughly assess the recall of the given information after a certain time in the evaluation. We can also evaluate the average recall.

2.4 Sample Size and Statistical Analysis

Considering the smaller number of probands in both research groups, a non-parametric statistical method was applied to compare the results, which does not require a Gaussian distribution of the data. The argument for choosing a non-parametric statistical method is that the Gaussian curve cannot be fully determined with a low number of individuals. For our statistical analysis, a difference score was always calculated between the test result at the entry and exit testing, which we performed with the probands. The difference values for the two groups that we studied were then

compared with each other using statistical tests with regard to the fact that they are dependent or independent sets (always at the 0.05 significance level). The results of the data analysis itself were then shown in individual tables and graphs, including illustrations according to the specifically used tests. The distribution of data density depending on the determined values is presented in the tables of individual research files in the descriptive analysis chapter. These results were also then displayed in graphs with respect to the observed significance level (P) value. If the P value is less than the significance level value of 0.05, then the result cannot be considered statistically significant. The comparison was made permanently between the experimental and control groups. The results are presented by performing a pre-test (input – first testing) and a post-test (output – second testing). The resulting comparison graphs point to the difference between the initial and final examinations of the given test both for individual groups and between research groups. When evaluating inductive analysis, we work with null and alternative hypotheses in mind. We used the IBM SPSS Statistics program for statistical data processing.

3 Results

From the total values of the experimental and control groups, shown in the summary Table 2, it is possible to draw attention to the similar input values. From the given table, it is clear that the shift of the experimental group reached an average of almost 9 score points, for the control group it was less than 1 score point. While the average values of the experimental (intervention) group had an increasing tendency at the entrance (pre-test) and exit (post-test), the results of the control group show rather stagnation. The results of the individual probands show that in the experimental group, there was a positive increase in all cases (except one). In some probands (E3, E7) even to a significant increase.

Table 2: Descriptive statistics of entry and exit testing of both observed groups (source: authors)

	Experimental group Entry testing	Experimental group Exit testing	Controlled group Entry testing	Controlled group Exit testing
Mean	8.27	9.95	8.61	8.84
Median	8.20	9.60	8.40	8.50
Standard deviation	2.33	1.87	0.875	0.958
Minimum	2.80	6.80	7.20	7.40
Maximum	12.6	13.6	10.0	10.4

Shifts in the control group did not differ significantly among the individual probands. The statistical processing of the obtained results is presented in Tables 3–4. Here,

a larger shift in the point evaluation for the experimental group is evident. When comparing the results of the entrance and exit testing of both groups, it is evident that there was no statistically significant difference in the entrance testing. Student's test points to $p = 0.631$ and Mann-Whitney test to $p = 0.618$. Thus, no statistically significant difference was demonstrated between the entrance tests of both groups. On the other hand, we can demonstrate a statistically significant difference between the experimental and control groups during exit testing. In the case of the Student's test, $p = 0.018$ and in the case of the Mann-Whitney test, $p = 0.040$.

Table 3: *Paired Samples T-Test experimental group (source: authors)*

		statistic	df	p
Experimental group – enter×exit	Student's t	-3.82	14.0	0.002
Controlled group – enter×exit	Student's t	-1.28	13.0	0.224

Note: $H_a \mu_{\text{Measure 1}} - \mu_{\text{Measure 2}} \neq 0$

Table 4: *The comparison of entry and exit testing of both observed groups: Independent Samples T-Test (source: authors)*

		statistic	df	p
Entry testing	Student's t	-0.486	28.0	0.631
	Mann-Whitney U	100.0		0.618
Exit testing	Student's t	2.504	28.0	0.018
	Mann-Whitney U	62.5		0.040

Note: $H_a \mu_1 \neq \mu_2$

4 Discussion

Research in recent years agrees that the number of children with clinically established diagnosis of neurodevelopmental disorders has been increasing. With this increase, an increase in the comorbidity of the given disorder and physical disorders has been also observed. Until recently, studies focused more on the connection between autism and physical disorders e.g., the relationship between autism and epilepsy. In addition to the frequent occurrence of epilepsy, an increased incidence of gastrointestinal problems, problems with food intake or excretion disorders were also observed in children. Some authors also report an increased incidence of asthma or headaches (Jokiranta et al., 2014; Chaidez et al., 2014; Zerbo et al., 2015; Kohane et al., 2012).

When specifying the given problems from the pedagogue's point of view, we primarily focus on issues in the field of learning. In this area, the learning rate slows down. These functions are then impaired even in adulthood. Likewise, in foreign sources, difficulties with learning contents that are not adapted to the actual level

of learning were reported (e.g., for teaching mathematics, it is provided at the level of 5th grade, although the skills are at the level of 2nd grade). Such discrepancy can lead to a limiting rate of progress in the affected areas. The child can also bear the consequences of incomprehension. Which can further worsen the learning process itself. The individual may also have problems with self-concept i.e., the individual must deal daily not only with learning but also with gradually accumulating harmful attributes. Such attributes include generally low intellect, laziness, and bad attitude. Further, it can lead to bullying (Altarac et al., 2007; Boyes et al., 2016; Reingle et al., 2016). After a while, the individual can also experience a loss of motivation. Giving up is typical for individuals since they wish to avoid harm (both physical and psychological). Adaptation is also problematic leading, for example, to behaviour that is disruptive or even antisocial. Moreover, the use of addictive substances is typical (Mascheretti et al., 2017; Svenson et al., 2001; McDowell, 2018). In adulthood, the risk not only in learning, but also in mental health, physical health, social relationships, professional application, or criminal behaviour may increase.

In foreign sources, the basic conceptualization of the assumption that SLD is an academically based disorder that originates in the central nervous system is still preserved. There are still different approaches to the nature of CNS disorders, such as what specific processing behaviours define it, or what neurological structures are associated with it. Others focus on questioning the legitimacy of SLD, asking how different these disorders are from low IQ or low intelligence. The long-held theory that SLD can be measured psychometrically using differences between abilities and outcomes has been challenged (Büttner et al., 2011; Kavale et al., 2009; Scanlon, 2013).

5 Conclusion

Special pedagogical care and intervention can be considered the basis of support measures in SLD. Such an approach should start as soon as possible, due to the higher plasticity of the central nervous system at an early age. and continue upon entering primary school. Educators should employ specific teaching strategies and teaching materials. Moreover, an individual education plan is formulated which aims to reduce or eliminate the child's difficulties in the educational process. Such difficulties may include reading, writing, and arithmetic. The child/pupil should undergo special pedagogical interventions, which can support the achievement of a certain degree of academic results. During such lessons, a special educator focuses, for example, with dyslexia on:

- i) Segmentation of phonemes: what sounds does the child hear, what is the last sound in a word, etc.
- ii) Dropping phonemes: what word would remain if we removed the M sound from the word MAT.

- iii) Phoneme matching: if the selected words start with the same sound.
- iv) Counting phonemes: how many sounds does the child hear in the word TAKE?
- v) Phoneme swapping: what word would be formed if you changed the letter P in the word POT and replaced it with the letter H?
- vi) Blending Synthesis of phonemes or Phoneme Manipulation: what word would be formed if you put the sounds together.
- vii) Rhyming: how many words can rhyme with EAT?

Usually, after the development of phonemic awareness, phonemic teaching itself begins. The child learns that these sounds (phonemes) are associated with specific letter patterns (phonics). The aim of teaching is to connect individual sounds with letters and thus promote fluency in reading and spelling (Demonet et al., 2004; Kulkarni et al., 2006; Karande et al., 2011). Based on the above, several questions arise that need to be taken into account. If we consider the combined effect of several diseases, we must also take this into account when working with these individuals. The problem of such combinations can be not only insufficient fulfilment of school or other duties but also a general problem with the full involvement of the given individual in society. This is one of the main individual outputs plenty of studies point to. The integrated approach of special education and rehabilitation approaches, or psychological appear to be effective. The combination of the experts' interaction becomes a relatively important indicator of quality care for a given individual and their relatives (Vostrý et al., 2022).

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(reviewed twice)

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