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Possible learning and reading disorder non-medication correction methods

Abstract

Learning disabilities, often connected with reading disorders, present major challenges to the educational system. Specific reading disability is a persistent reading dysfunction. A person with a specific reading disability is unable to acquire reading skills disregarding sufficient intellectual and speech capabilities and normal speech and hearing analyzer function in an optimal learning environment. New non-medication problem solutions are constantly searched for. Since modern technology and knowledge about alternative treatment of pathology such as tension-type headache that can cause learning difficulties and consequently, develop reading disorders, is constantly developing, the importance of the Biofeedback (BFB) method is increasing.

The aim of the study was to determine the efficiency of BFB on children with migraine and learning disorders, including reading disorder.

Theoretical methods: analysis of medical, psychological and pedagogical literature; empirical methods: testing with Task Force® Monitor device (CNSystems Medizintechnik AG), Analog Visual Scale, Biofeedback X-pert 2000, parametric statistic analyses, a complex evaluation of cognitive abilities was used to detect specific reading disorders. Five boys with migraine and learning disorders accompanied with dyslexia participated in this study, age $10 \pm 0,5$.

The children took part in 12 BFB temperature sessions, resulting in a reduced frequency of migraine attacks from 7 – 1 times, $3,0 \pm 2,3$ times a month on average. No changes in migraine intensity were observed. Two participants stopped use of tranquilizers, that could be explained with a positive BFB effect on the autonomic nervous system. All participants showed a better academic performance and a trend of improved reading fluency at the end of the course.

The acquired data and literature analysis show that the usage of BFB has a potential in migraine treatment in children, it increases the quality of life and reduces learning and reading disorders. An increase in efficiency is possible with the inclusion of relaxation training. To reduce reading and language disorders, a complex system of therapeutic methods, including BFB, coordination exercises of percussion instrument play, relaxation and cognitive training sessions should be developed.

Key words: *learning disorders, dyslexia, biofeedback, sensorimotor coordination, acquisition, playing percussion, migraine*

Introduction

Learning disabilities play a huge role in the quality of educational system, affecting 15% of student population (Learning Disabilities Association of America, 2011). Learning disorders can affect the quality of life and academic performance. It is very important to search for new solutions for this problem as it is relatively inexpensive to provide teens with help and support in this matter. It has been pointed out that approximately 80% of USA teenagers have learning difficulties associated with reading disorders and approximately 35% of teenagers with learning disabilities never graduate high school (TeenHelp.com, 2011).

A specific reading disability is a persistent reading dysfunction. A person with a specific reading disability is unable to acquire reading skills disregarding sufficient intellectual and speech capabilities and normal speech and hearing analyzer function in optimal learning environment (Klicpera et al., 2007). Reading disabilities are a multidimensional problem with a variety of causes: endogenous or primary causes – genetic, brain activity, general health and psychosomatic disorders; complex, exogenous or secondary causes – family, nurture, socioeconomical environment and school environment (Schulte-Körne, 2009). A specific reading disability is a subject to 4-15% of the world population (Klicpera, 2003). Specific reading disability secondary symptoms – psychosomatic disorders, antisocial behaviour, low learning motivation, etc., affect 5-10% of schoolchildren (Shane, et al, 2005).

Despite the magnitude of this socio-educational problem, currently used methods have not been successful. Medication overdose is frequently observed in the solution of these problems, so alternatives to standard therapy with medication are constantly searched for, such as cognitive therapy, relaxation training, practice of autogenous training and the Biofeedback method. Biofeedback (BFB) is a non-medication method, based on the autonomic nervous system (ANS) modulation, stress level and excitement reduction, aiming to decrease the usage of medication and thus possible side-effects. It is especially important for children and adolescents, because side-effects of drug use can significantly affect the quality of life, educational process and functions of the body.

BFB includes a set of procedures that comprise the use of electronic devices to measure, process and give a person feedback about their body functions and which provide specialists – therapists, psychologists, speech therapists and teachers – with a deeper understanding about the pathology or disorder. BFB gives a deeper insight into a normal and pathological neuromuscular and ANS function. Analogue and binary, audio and visual information is presented to the person to understand processes of one's own body, solidify belief in increase of voluntary control of physiological processes. Initially the signal is controlled, but later, using the adaptative capabilities of the human body, especially on the sensory level, symptoms can be controlled, reduced or even eliminated (Schwartz & Andrasik, 2003).

The priority of the method is to partly or fully replace drug therapy and minimize side effects. It is very important for children and adolescents, where medication can be especially contraindicated. The BFB method consolidates the potential of modern technology with achievements in psychophysiology that lets a person realise his/her vegetative function and with voluntary interference change it, thus in long term achieving a positive development of treatment. BFB includes registration and visualisation or auditory representation of physiological functions, such as heart rate, muscle tension, skin temperature, breathing frequency, etc. (Figure 1).

A successful self-control of one's vegetative function is followed by a change of visual or auditory feedback that represents a change in physiological state of the human body. Psychosomatic disorders often affect the autonomic nervous system (ANS): activity of sympathetic nervous system (SNS) is increased and therefore sympatho-parasympathetic balance is altered. BFB allows to effectively train and learn to control one's vegetative function, normalize ANS balance and lower excitement. The result is relaxation of the body and decrease of illness/disorder symptoms.

There is evidence that the application of BFB for children with reading disability is effective. As a result of a serial application of electromyographic and sensorimotor BFB training for a 10-year old boy with hyperactivity and attention deficit disorder, a reduction of developmental reading disorder symptoms was observed. Lessening of symptoms was achieved in three ways: decreasing muscle tension, increasing the activation of Roland cortex and reducing the child's motor activity level. Previously these effects were observed only with medical administration (Tansey & Bruner, 1983).

Clinical experience also provides a strong support for this suggestion (Kaiser & Othmer, 2000). In a case study a 17-year-old subject with a reading disability was involved. the participant underwent 20 sessions of BFB training. Upon completion of all 20 sessions his comprehension score on the Burns Roe Reading Passages increased from 45% to 90% and he improved his score in Wechsler Individual Achievement Test reading comprehension subtest to a standard score of 99 for his age and grade level (Thornton, 2002).

Another case study represents an example of a child with significant history of reading problems. After a treatment with 25 BFB training sessions the child's auditory memory function significantly improved. Following approximately 40 BFB training sessions the child showed better reading capabilities with significantly increased Lexille score in comparison to the previous year's testing. Increased self-confidence, greater reading fluency and ability to present information orally were observed (Dubin, 2005).

Studies have proved that the BFB method is useful for stuttering treatment as well. A study by Civier, Tasko & Guenther (2010) investigated stuttering linked

with the motor function of language. It is thought that the usage of BFB method increases the motor system activity and improves the language function, and consequently reduces stuttering.

Reading disorder causes can be psychosomatic and connected with changes in the way the brain works. Increased excitement levels and decreased stress tolerance, together with learning disorders, physiological functions of the body and physical condition of the person, would allow to develop an appropriate BFB model to decrease psychosomatic symptomatic in case of above mentioned symptoms. Although the BFB method is relatively widely used to lower excitement and increase stress tolerance, research up to now has been unrelated and incomplete.

Research in Latvia (Jēgere, Puriņa, Voita, Ābele, 2005) shows that headache and migraine among children are a serious problem and, when connected with socioeconomical environment and disbalance in school curriculum, it becomes even more significant and has an impact on reading and learning. Usually parents choose medication as the easiest way out, sometimes without consulting a general practitioner, in such a way endangering the children's life quality and academic performance, not to mention a potential development of speech impairments.

Psychological and physical behavior control methods, including BFB are effective in the treatment of migraine and tension-type headache. The most effective methods in migraine treatment are temperature BFB, electromyography and cranial blood volume pulse amplitude (PVA) control methods separately or accompanied by cognitive behavioral therapy or relaxation training sessions (Blanchard & Andrasik, 1987; Sarafino, 2008). Most effective methods in tension-type headache treatment are EMG Biofeedback training sessions that can be carried out jointly with relaxation training sessions and cognitive behavioural therapy. This method is evaluated as even more effective than medication treatment with amitriptyline (Penzien et al 2002). It is confirmed by other authors (McCrory et al., 2001) in their work about effects of BFB on migraine and tension-type headache treatment, where a statistically significant difference was found in comparison with the control group or placebo group. BFB effects on migraine are evaluated with level 4, and on tension-type headache with level 5 (highest possible) (Nestoriuc et al., 2008). It is thought that if BFB therapy is complemented with additional practice in home environment the results are improved even more (Nestoriuc & Martin, 2007). Others have arrived at similar results, when summarizing information about the efficiency of BFB in teenage migraine therapy (Kabbouche & Gilman, 2008).

Temperature and blood volume pulse amplitude changes are the most commonly used BFB methods in migraine and other ache treatment both for children and adults, resulting in a statistically significant pain decrease. For example, in a study where 30 minute hand warming sessions were carried out 4 times a week for 6 weeks statistically significant decrease in headache index ($p < 0.05$), intensity ($p < 0.01$) and headache frequency ($p < 0.02$) in comparison with the control group

or group where the temperature of hand skin got lowered in training sessions. No specific effects of BFB were observed on headache caused by hormonal fluctuations associated with menstrual cycle although the number of migraine attacks ($p < 0.01$) and the use of medication after 12 hand warming sessions decreased (Blanchard & Kim, 2005). Note that there is contradictory data about the BFB efficiency in the treatment of menstrual migraine because there is no consensus definition of menstrual migraine and hormonal fluctuations have been studied in different phases of the menstrual cycle (Schwartz & Andrasik, 2003). During adolescence fluctuations associated with the menstrual cycle is the most prevalent cause of headache for girls and by understanding and learning to control processings of one's body, girls could improve their academic performance and overall quality of life (Jēgere et al., 2005). Using blood volume pulse amplitude BFB training of *a. temporalis* (eight 1 hour sessions) similar improvements were observed as when using cognitive therapy for migraine and tension-type headache treatment (Martin et al., 2007). In another study no differences were found – PVA of *a. temporalis* BFB efficiency was 32% of total efficiency in comparison with temperature BFB in combination with cognitive therapy – 33% (Schwartz & Andrasik, 2003). Studies about brain activity in migraine patients show that self-regulation training can affect neuromodulation and therefore decrease pain intensity and frequency (Siniatchkin et al., 2000).

There is also data that does not reveal positive BFB effects combined with relaxation training sessions in migraine and tension-type headache treatment (Mullally et al., 2009).

Positive effects of electromyography relaxation have been found on treatment of emotional stress related skin conditions such as atopic dermatitis, neurodermatitis, psoriasis, etc. (Shenefelt, 2005). Temperature BFB, electromyographic and relaxation training as complementary methods in dermatology are suggested for children with increased anxiety (Fried & Husain, 2008). Research shows that increase of relaxation and self-control of physiological processes induces decrease of symptoms (Fried, 2002). Undeniably external appearance is very important during teenage years and skin problems can result in increased stress levels that significantly affect memory, perception and attention.

A study was carried out with 150 children participants with an aim to lower their anxiety levels. After six electromyographic training sessions over 6 weeks' time and six temperature training sessions health levels were improved. These results confirm the efficiency of the BFB method and show that BFB can be used to treat anxiety and associated conditions such as reading disorders, memory and attention problems in children (Wenck & Leu, 1996).

Increased stress level in everyday life is one of the main causes of Bruxism (when you clench or grind your teeth) (Lobezzo et al., 2006). The use of BFB has proved to be successful in increasing individual stress tolerance and decreasing the

tension of facial muscles (*m. masseter*) that has beneficial effects on overall health and language (Kardachi & Clarke, 1977; Foster, 2004).

Aim of the study: The aim of our study was to determine the effectiveness of the BFB therapy for children with migraine associated learning and reading disorders.

Materials and methods: Five male participants aged 9-11 took part in this study with their parents' consent. The children had problems both in their studies and in social communication. During relative physical rest, testing with Task Force® Monitor device (CNSystem Medizintechnik AG) was used for sympatho-parasympathetic balance detection. Beat-to-beat heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate variability (SRV) in normalized units (n.u.) and respiration frequency were registered. Before and after the BFB training sessions migraine frequency and intensity over a period of a month were registered, using the persons' diaries and Subjective Visual Analogue Scale. The temperature BFB training session protocol was used. The children performed 15 minute training sessions twice a week with the aim of increasing the temperature of hand skin using Biofeedback X-pert 2000 device (Schuhfried, Austria). The children were asked to perform 10 minute training sessions twice a week on their own without the presence of a specialist and BFB module. A complex evaluation, that comprises reading skills test, short-term memory and attention capacity diagnostics, and detection of specifics of one's visual and audial perception was used to detect specific reading disorders. Preliminary evaluation of general intelligence is essential.

Results and conclusions:

Before the BFB training sessions the migraine attack frequency was $7,2 \pm 3,4$ per month; after the completion of the training it went down to $3,0 \pm 2,3$.

As shown in Table 1, functional properties of ANS reveal no significant difference in comparison with previously in other studies tested healthy control group children (Greene, 1991), although we have to note that the number of such studies is insufficient and there is lack of data about aforementioned properties. Although the number of participants is very small, even within this group positive effects of training are clearly visible. As shown in Figure 2, after BFB migraine frequency decreases. However, no decrease of migraine intensity was observed, although that might happen if the group of participants were larger.

The evaluation of reading skills, short-term memory and attention capacity show an insignificant trend of overall improvement. To acquire more significant conclusions intensive work is taking place right now in RTTEMA Psychology and Pedagogy Research Institute in collaboration with UL Institute of Cardiology and

child neurologists. Also, 2 children stopped using tranquilizers (Novo-Passit 1 pill twice a day and Relaxen 1 pill twice a day), citing the grounds of improved self-control in stress situations and decreased subjective levels of anxiety. The efficiency of the BFB method might be linked to four reasons mentioned by Attanasio et al. (1985):

- children perceive BFB as a game, therefore they are more motivated and interested in the procedure ;
- children are less skeptical about the efficiency of the BFB method;
- children are more successful in following the instructions and doing “homework”;
- children are more confident about their abilities.

The results confirm the possibilities of BFB usage in children migraine reduction and increase of life quality. As mentioned before, the authors failed to find a significant amount of data about research in this field, but the acquired data coincides with that of other authors (Hermann et al., 1995). The results of this study were not compared with those of a control group, and no combining with other methods (e.g., musical and physical training) was carried out that could provide additional information in such a way securing a more successful expected result. For example, a study was found that showed a similar result of BFB and relaxation training combination usage to that of our study where only BFB was used. It highlights the need to look for new combinations for BFB usage.

To increase the efficiency of training it is planned to complement the study with breathing relaxation trainings, that as shown before (Powers & Hershey, 2005) complement BFB trainings, to determine whether this combination decreases not only the frequency of migraine attacks, but also pain intensity along with an improvement of language and the quality of learning process. Studies have been carried out before that link language improvement with music. It is hypothesised that language and music processing is taking place in overlapping brain regions, namely, the frontal cortex. As a result, improved music processing can enhance the language function and vice versa (Patel, 2003).

As mentioned before, music develops listening skills to children with learning disorders (Humpal & Wolf, 2003). Recent research has given physiological basis to these studies. While listening to music or speech, brain simultaneously and rapidly receives enormous amounts of information, that needs to be processed (Blakemore & Frith, 2000). The perception and speed of processing depends on the previous experience. Positive effect on the processing speed of the human brain forms automatically, while listening to music. Musical experience optimizes the brain’s processing speed that influences language perception that has an impact on reading skills (Hallam, 2010).

Musical learning improves overall perception through sound perception (Gaab et al., 2005; Tallal & Gaab, 2006; Patel, 2009) developing a better auditory resolution that influences cortical linguistic processes (Magne et al., 2006). Positive

results of musical learning can be observed relatively soon. Eight-year olds that had been practicing music for only 8 weeks differed from the control group in electrical activity in cortex (Moreno & Besson, 2006). Another group of scientists (Flohr et al, 2000) carried out 25 minute sessions for 7 weeks in groups aged 4-6, while analysing brain activity and comparing it with a control group. EEG waves that indicate increased cognitive activity were found in children who took part in music practice sessions. Children, who study music from early age (<5 years old) learn to pronounce syllables sooner than others. Musicians develop an elaborate peripheral hearing system; all mentioned processes are subject to the intensity of musical practice (Wong et al., 2007). Latest research has confirmed that skills in music have an impact on acquiring a second language and reading skills in the native language as well as a skill to interpret the rhythm of speech (Anvari et al., 2002).

Pre-school children showed a correlation between musical skills and skills to operate with language symbols (Peynircioglu et al., 2002), phonological skills and skills to operate with letters (Anvari et al., 2002). Another study involved kindergarteners who practiced music 30 minutes a week for 4 months (Gromko, 2005). The programme consisted of active music making connected with kinaesthetic movements with the goal to link movements with music, melody to rhythm, and provide understanding of interaction between sound and symbols. The children showed a better phonemic awareness, a skill to create associations between the perceived sound and visual symbols.

In this context research under the supervision of RTTEMA professor Marnauza has to be noted (Gžibovskis, Marnauza, Voita, Perepjolkina, 2009). Regular percussion practice as well as coordination exercise performance of a percussion instrument play originated by T. Gžibovskis efficiently develops the youths' sensorimotor coordination only after 6 months of practice. That lines with latest language theories (Glenberg, Gallese, 2011) that propose that the mechanism of motor control is employed for language learning, comprehension, and production. These data highlight the need to combine BFB with musical practice for more successful results in reading and learning disorder treatment.

As mentioned before the data acquired in this study will be complemented in further research. In this study only the data before and after BFB training for the target group was compared; it is necessary to analyse the efficiency of the method in long term after the completion of training sessions. The data about temperature BFB is similar to those of *m. frontalis* electromyogram BFB reported by Fentress et al. (1986), although there is a view that it is not possible to directly compare data acquired from one BFB modality to another, because, as mentioned before, different modalities are efficient in the treatment of different pathologies.

A research has been undertaken concerning the use of BFB for other psychosomatic disorders, but to present precise data, it is necessary to increase the number of participants.

This study confirms the efficiency of BFB in children migraine treatment, improving the quality of life, reading and performance. We firmly believe that the started research gives an insight in possibilities to improve children learning disorders by decreasing stress levels and the frequency of associated migraine attacks. Based on the literature analysis and research carried out by RTTEMA and UL Institute of Cardiology, we believe that complex therapeutic methods should be developed with the inclusion of BFB and the already developed coordination exercises of percussion instrument play, relaxation and cognitive trainings. The BFB method has shown to be a perspective method in Latvia alongside medication based therapy to increase the quality of life for children and adolescents with dyslexia and learning disorders.

Figure 1. **Working principles of Biofeedback** (*Behavioral Medicine Research and Training Foundation, 2011*)

Age (years $\pm$ SD)	SF (beats/min)	SAS (mm Hg)	DAS (mm Hg)	SRV (n.u.)	Breathing frequency (cycles/min)
10 $\pm$ 0,5	80,4 $\pm$ 8,3	104,3 $\pm$ 4,9	64,2 $\pm$ 4,7	0,8 $\pm$ 0,1	20,1 $\pm$ 5,9

Table 1. **Data about ANS function of children at rest after 5 minutes of recording** (*median $\pm$ standartdeviation*).

Figure 2. Number of migraine attacks/month before and after BFB.

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