Interdisciplinary Contexts of Special Pedagogy
NUMBER 21/2018

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A person with hearing impairment as a recipient of art – the borderline ofspecial needs education and neuroeasthetics

Abstract: Elżbieta Lubińska-Kościółek, Jolanta Zielińska, *A person with hearing impairment as a recipient of art – the borderline of special needs education and neuroeasthetics.* Interdisciplinary Contexts of Special Pedagogy, No. 21, Poznań 2018. Pp. 233–246. Adam Mickiewicz University Press. ISSN 2300-391X. DOI: https://doi.org/10.14746/ikps.2018.21.13

In this paper the research of art perception by people with hearing disorder has been presented. This study has been performed from the perspective of special pedagogy and neuroesthetic. The encephalography technique and QEEG analysis has been performed with usage of Mitsar-EEG-202 head. This device is controlled by WinEEG software which allows qualitative and quantitative analysis many aspects of EEG signals integrated with two physiological sensors: rhythm of heard and amplitudes of blade pulse and breathing. The results of this study shown usability of the proposed research process for identification new research topics in area of special pedagogy. They also illustrated as many important information about influence of disorder on functioning disable person may be collected by such study. This related in this case to neurological aspects of art perception by by people with hearing disorder.

Key words: hearing disorder, brain, art

1. Foreword

In his book *Splendors and Miseries of the Brain: Love, Creativity and Quest for Human Happiness*, Semir Zeki, in his original way, discusses the neurobiological foundations of human creativity. As the founder of neuroaesthetics, the discipline that deals with the neurobiological foundations of aesthetic perception, he claims that each stage of visual art, from planning through creating to perceiving, must comply with the laws of visual perception and that artists may be compared to brain researchers using specific research methods. Although art, love and beauty are generally considered to be abstract concepts, there are more and more arguments confirming that the experiences associated with them are closely linked to the activity of specific parts of the brain[1].

The tests presented subsequently, concerning specific art perception by adults with hearing impairment, were conducted on the borderline of special needs education and neuroaesthetics. Their basic objective was to determine the specific patterns of bioelectrical brain activity oin adults with hearing impairment during art perception and how it differs from the same activity in hearing persons. The tests are preliminary in nature, however, despite the relatreively small test group, the results already seem significant for the broadly understood rehabilitation and inclusion of persons with hearing impairment. They create new possibilities for generating new solutions and, most importantly, for rehabilitation of hearing-impaired persons. Additionally, the tests confirm the interdisciplinary nature of special needs education and prove the usefulness of research on the borderline of special needs education and other disciplines, including neuroaesthetics, for example in the area of diagnostics, therapy and rehabilitation planning aimed at equalising the chances of persons with disabilities[2], according to the assump-

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[1] S. Zeki, *Splendors and Miseries of the Brain: Love, Creativity and the Quest of the Human Happines*, Wydawnictwo Wiley-Blacwell, Malden 2008, pp. 15–20.

[2] J. Zielińska, *Metody obrazowania pracy mózgu w perspektywie pedagogiki specjalnej – wybrane zagadnienia*, Wydawnictwo Naukowe UP, Kraków 2015, p. 32.

tion that the major value of neuroimaging examination consists in the usefulness of its results for planning optimum individual rehabilitation programmes[3]. A separate problem is to improve the quality of life of persons with disabilities and increase their educational, social and professional chances, also as visual, musical or literary artists.

The tests presented subsequently diagnose bioelectrical brain activity in adults with hearing impairment during art perception[4].

2. Methodological bases for testing the specific patterns of bioelectrical brain activity in adults with hearing impairment during art perception

Purpose of the tests: The purpose of the tests was to determine the specific patterns of bioelectrical brain activity in adults with hearing impairment during art perception and how it differs from the same activity in persons without hearing impairment. Also, by evaluating changes in physiological parameters in the subjects of the tests, the accompanying emotions were examined and, at the same time – to a limited extent – the activity of the sympathetic and parasympathetic nervous systems responsible for those emotions. The following questions were posed: How strong are the emotions of students with hearing impairment when they look at works of art – paintings? Do the emotions of deaf students differ in specific cognitive situations from those of hearing students, and if they do – what is the degree of those differences? Is the emotional reaction of hearing students and deaf students in line with their aesthetic feelings?

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[3] K. Cieśla, *Plastyczność układu słuchowego – badania z zastosowaniem metod neuroobrazowania,* „Nowa Audiofonologia" 2013, no. 2(3), pp. 16–23.

[4] J. Zielińska, *Wybrane techniki obrazowania sygnałów w perspektywie pedagogiki specjalnej – przykłady zastosowania w praktyce diagnostyczno-terapeutycznej*, Wydawnictwo Naukowe UP, Kraków 2016, p. 133–146.

Test group: The tests covered a group of 8 students with hearing impairment and 30 hearing students aged 22 and 23. All the subjects of the tests were informed about the research procedures and gave their written consents. The students with hearing impairment were purposively sampled. They were persons with innate hearing impairment, deaf or hard of hearing, using hearing devices (implants or aids) and without multiple disabilities. Four of the respondents came from hearing families and the other four had deaf parents. All of them were fluent users of the sign language, and five of them also used the phonic language.[5]

Test methods: The tests were conducted as individual case studies[6]. This particular method was chosen due to the fact that the tests are innovative and the research group is relatively small.

Measuring techniques: The technologies used in the tests were encephalography, QEEG analysis and a test station with Mitsar-EEG-202 head and WinEEG software for quantitative and qualitative analysis of various aspects of the EEG signal. The QEEG analysis is a record of bioelectric activity that enables not only qualitative assessment but also quantitative assessment of the ratio and strength of the respective frequency bands in the analysed image. Brain activity determined on the basis of such tests is illustrated by waves of specific frequencies that suggest the condition of the subject. They include:

- Delta waves (δ) – frequency up to 4 Hz, typical of sleep stages 3 and 4 (NREM),
- Theta waves (θ) – frequency 4 to 8 Hz, typical of hypnotic conditions: trance, hypnosis, light sleep (associated with sleep stages 1 and 2 NREM). FMθ (frontal midline Theta) Theta rhythm, typical of such cognitive activities as attention and memory processes.

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[5] J. Zielińska, *Wybrane techniki obrazowania sygnałów w perspektywie pedagogiki specjalnej – przykłady zastosowania w praktyce diagnostyczno – terapeutycznej*, Wydawnictwo Naukowe UP, Kraków 2016, p. 133.

[6] T. Pilch, T. Bauman, *Zasady badań pedagogicznych. Strategie ilościowe i jakościowe*, Wydawnictwo Akademickie „Żak", Warszawa 2001, pp. 77–79.

- Alpha waves (α) – frequency 8 to 13 Hz and amplitude around 30-100 μV, typical of lack of visual stimuli (closed eyes). During visual perception, they are suppressed. They are typical of relaxed state and limited cognitive activity.
- Beta waves (β) – frequency 12 to around 30 Hz and amplitude below 30 μV, typical of the engagement of the cerebral cortex in cognitive activity. They may suggest that the subject's attention is focused. However, they may also be activated by various pathologies or chemical substances[7].

The slowest Delta waves are the waves of the unconscious state, present in deep sleep. At this stage, the synthesis of cortisol, responsible e.g. for stress and ageing, is reduced, and the levels of DHEA and melatonin increase. Theta waves are a band at the borderline of consciousness, associated, e.g. with intuition; they accompany creative processes and stimulate processes that integrate the body and the mind, e.g. during mediation. If their level is too high, they cause focus and concentration disorders. The Alpha band is associated with a state of relaxation but at the same time attention. In these tests, the Beta group of waves is very important, consisting of SMR (12–15 Hz), Beta1 (15-22 Hz) and Beta2 (22–50 Hz). SMR is called the low Beta band. It is the processing rhythm of sensory information received by the senses, also called relaxation with simultaneous external attention. Medium Beta, namely Beta1, is activated during intellectual activity: concentration, thinking, analysing and problem solving. The high Beta band – Beta2 – is associated with increased emotional tension, stress, anxiety or high energy consumption. It is correlated with the release of stress hormones (mainly adrenaline) The Gamma band is the least known wave. It may be found across the entire brain area and is probably linked with association processes and integrative thinking. It may accompany extreme emotions[8].

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[7] http://www.emeraldinsight.com/journals.htm?articleid=1840314 [accessed: 20.02.2018].

[8] J. Zielińska, *Wybrane techniki obrazowania sygnałów w perspektywie pedagogiki specjalnej – przykłady zastosowania w praktyce diagnostyczno-terapeutycznej*, Wydawnictwo Naukowe UP, Kraków 2016, pp. 118–119.

In experimental tests, the EEG signal was registered in nineteen electrodes set up according to the international 10–20 system, using the reference setup of connected earlobes. At impedance below 5 kΩ and sampling frequency 250 Hz, the EEG signal was filtered in the band 0.53–50 Hz. The tests also used: the BPV sensor to measure heart rate variability (photoplethysmography). It is attached to the finger and analyses the heart rate and pulse amplitude, while a breath sensor measures the breath rate and amplitude. It is attached to the thoracic diaphragm and breast area with a velcro strap.

Based on the test results, LF, HF and LF/HF ratios were determined. HF – high frequency spectrum 0.15-0.4 Hz reflects the activity of the parasympathetic nervous system and is often correlated with respiratory variability; LF – low frequency spectrum 0.04-0.15 Hz. this showed the activity of two ANS branches: the sympathetic nervous system and the parasympathetic nervous system. The LF/HF ratio increase suggests increased activity of the sympathetic nervous system[9].

The tests consisted of 4 measurements. The 1st measurement was a recording of bioelectric activity at rest with open eyes (3 minutes). The other three measurements were taken while the subjects looked at painting (the total of 75), divided into three main categories and presented every 7 seconds. The respective categories were shown after a 3-minute brake. On the computer screen, the subjects looked at, respectively: representational paintings, abstract paintings and paintings expressing particularly negative emotions. The paintings were selected in consultation with a painter. After the measurements were taken, the subjects were asked to look at the paintings one more time and assess their aesthetic value on a scale of 0 (ugly) to 5 (beautiful). As was already mentioned, the main purpose of the tests was to determine the specific patterns of bioelectrical brain activity in adults with hearing impairment during art perception.

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[9] http://www.akademiamedycyny.pl/geriatria/archiwum/201404/201404_Geriatria_004.pdf [accessed: 18.03.2018].

Also, by evaluating changes in physiological parameters in the subjects, the accompanying emotions were examined, namely the activity of the sympathetic and parasympathetic nervous systems. The sympathetic nervous system is the part of the autonomic nervous system responsible, e.g. for "stimulating" the organism and its reactions to stress. It is active mainly during the day, unlike the parasympathetic nervous system, which is active mainly at night. Its fibers cause, among other things: widening of the pupils, raising of hair, sweating of the hands, increased heart rate and narrowing of blood vessels, e.g. in the skin[10]. Thus, the tests to a limited extent concerned the emotionality of persons with hearing impairment and the possible resulting differences in reaction to the same artistic visual stimulus compared to hearing persons.

Based on the results of empirical tests presented in the literature, it is claimed that deaf persons are emotionally immature and have emotional disorders. It was observed, among other things, that they have too strong emotional links with the family, are egocentric and experience a feeling of inferiority. It was demonstrated, for example, that the more severe the hearing impairment is and the less developed the speech is, the stronger emotional disorders deaf children develop. They fail to perceive and understand most information, which limits their ability to participate in the life of their most immediate environment. The sense of isolation that develops gives grounds for strong negative emotional reactions, such as irritation, anger or aggression[11]. Such children are passive and negative and have low self-esteem and high levels of fear. They avoid contacts with hearing persons and their achievements are not adequate to their possibilities[12]. Research concerning the specificity of psychoso-

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[10] http://pl.wikipedia.org/wiki/Autonomiczny_uk%C5%82ad_nerwowy [accessed: 23.03.2018].

[11] A. Zborucka, *Ćwiczenia z surdopsychologii,* Wydawnictwo Naukowe WSP. Kraków 1983, p. 63.

[12] G. Dryżałowska, *Rozwój językowy dziecka z uszkodzonym słuchem a integracja edukacyjna: model kształcenia integracyjnego*, Wydawnictwo Uniwersytetu Warszawskiego, Warszawa 2007, p. 50.

cial development of children with hearing impairment shows that their emotional, social and cognitive development to a large extent depends of the development of speech and, at the same time, communicative possibilities[13]. Research concerning the specificity of the language describing the emotions of deaf students, focusing on optimum strategies to teach "the language of feelings", was to a limited extent conducted on the level of special needs junior high school and high school[14]. A person receives sensory information in the form of stimuli perceived by the hearing, vision, touch, smell and taste receptors. If any of the senses is damaged, the image of reality created in one's consciousness is incomplete or distorted. Hearing stimuli are the source of important information. They reach a person from all directions, thanks to which one is constantly in contact with the environment. They inform about events that happen at a longer distance, beyond eye contact. Also, the constantly stimulate attention, interest and curiosity. They influence human behaviour, making it possible to express emotions and feelings, and shape the personality. They condition the establishment and maintenance of social contacts[15].

Research on the self-esteem of adults with hearing impairment, including their inclination to depressive behaviour and ways of coping with stress, led to the conclusion that this group is characterised by lower self-esteem than the hearing population. In the case of children as well as youth and adults, self-esteem is raised by identification with the deaf, bilingualism or biculturalism. Nonetheless, research suggests that problems with mental health in adults with prelingual deafness occur more frequently than in hearing persons, regardless of the preferred method of communicating with the envi-

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[13] A. Jegier, M. Kosowska, *Relacje dziecka z wadą słuchu w szkole*, Wydawnictwo Difin SA.Warszawa 2011, p. 60.

[14] Z. Orłowska-Popek, *Emocje w wypowiedziach uczniów niesłyszących*, Wydawnictwo Naukowe UP, Kraków 2011, pp. 5–7.

[15] J. Cieszyńska, *Od słowa przeczytanego do wypowiedzianego. Droga nabywania systemu językowego przez dzieci niesłyszące w wieku poniemowlęcym i przedszkolnym*, Wydawnictwo Naukowe UP, Kraków 2001, pp. 9–10.

ronment, i.e. phonic language, sign language or bilingualism[16]. The problem concerns the strongly distorted "self-confidence" of the deaf.

3. Results and conclusions of the tests on the specific patters of bioelectrical brain activity in adults with hearing impairment during art perception

In the research, the term "emotions", according to the neuropsychological description, was understood as unconscious and automated body reactions to stimuli that are important for the survival of the species[17]. On the other hand, feelings articulated verbally were treated as the conscious interpretation of emotions on the basis of cultural patterns and experiences coded in memory, and the evaluation of situation dictated by them. The same emotion, understood as a mental process that is independent of the will and is a reaction of the organism to stimuli, may be interpreted as different feelings, depending on the situation[18]. The results of the research were interesting. Students with hearing disorders, the same as hearing students, correctly named the feelings accompanying the perception of paintings, and sometimes those feelings were more intensive than in hearings students. In most cases, they used the sign language to name their feelings. The intensity of feelings is exemplified by the following comment made by a deaf student to one of Zdzisław Beksiński's paintings: "…It is disgusting, it made me feel sick…"

The subjects of the research were students of various fields: special needs education, mathematics, graphics and technical and IT

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[16] J. Kobosko, *Doświadczanie objawów depresji u osób dorosłych z głuchotą prelinwalną korzystających z implantu ślimakowego a sposoby radzenia sobie ze stresem i samooceną,* „Nowa Audiofonologia" 2014, no. 3(1), pp. 34–45.

[17] A. Herzyk, *Mózg, emocje, uczucia. Analiza neuropsychologiczna*, Wydawnictwo UMCS, Lublin 2000; pp. 7–8.

[18] http://pl.wikipedia.org/wiki/Emocja [dostęp: 23.03.2018].

education. They declared different interests, mainly associated with sport, visual art, literature, music. Even a preliminary analysis of the empirical material, namely measurements taken in relaxed state with open eyes in the group of able students and students with disability showed huge individual differences. Differences were even reported between two monozygotic twin sisters, who participated in the research. The empirical material selected to illustrate the individual differences between the two groups, which seems to confirm the conclusions presented in the former chapters, were the test results of two graphics students: a 22-year-old deaf student and a 21-year-old hearing student. The interests of the two women as well as their aesthetic evaluations of paintings were similar. Compared to other subjects, their evaluations were high. Neither of the women gave an extremely low assessment and in each of the presented categories, they found paintings that they considered to be particularly beautiful, and often, their choices were identical. Test results, in the form of topograms determining the percentage share of the respective frequency bands in the EEG spectrum in the open eyes category, showed a trend associated with bioelectrical brain activity, characterised by lower values in the Alpha band and higher values in the fast frequencies (Beta2 and Gamma), compared to the abled person. In subsequent tests, when the subjects were shown paintings in three categories, bioelectric activity underwent similar changes, on a level typical of each individual[19].

The tests show that, compared to the base measurement, in all the categories of the paintings, the deaf subject displayed a more general value in slow bands and reduced activity in the Theta and Alpha bands, and increased activity in Beta1. More general were also higher frequency bands of Beta2 (20–30 Hz) and Gamma (30–40 Hz). As was already mentioned, lower values in slow frequency bands and increased activity in the Beta1 band are associat-

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[19] J. Zielińska, *Wybrane techniki obrazowania sygnałów w perspektywie pedagogiki specjalnej – przykłady zastosowania w praktyce diagnostyczno-terapeutycznej*, Wydawnictwo Naukowe UP, Kraków 2016, p. 138.

ed with cognitive activity. To compare bioelectric activity during the perception of abstract paintings and representational paintings, increased activity in Theta, Beta2 and gamma bands was reported. A slight increase was also reported in the Beta1 band. This could be caused by the nature of the stimulus and its equivocalness, as well as an intensive search for interpretation. The changes reported between the second test and the third test, which involved paintings expressing negative emotions, consisted in more general appearance of slow frequencies radiating to the left hemisphere and lowered values in the Beta1 band. At the same time, further increase was reported in the slow frequency band Beta2. It seems that the focus of attention significantly dropped and (or) an intensified emotional reaction happened, which is confirmed by the physiological parameters described hereinbelow[20].

An analysis of the physiological parameters did not show any regularity in the group of subjects with hearing impairment, although such regularity was strongly marked in the group of hearing subjects. In a few persons, a gradual growth in the LF/HF ratio was reported, reflecting the ratio of the spectrum strength in the frequency range characterising the activity of the sympathetic nervous system to the spectrum strength in the frequency range characterising the activity of the parasympathetic nervous system. It reached the highest value in the last test, associated with the perception of an artistic object with strong emotional connotations. The results suggest that the activity of the sympathetic nervous system increases under the influence of this category of stimuli. In the group of persons with disabilities, the results were so varied that to make any conclusions, a larger population would have to be tested. It was noted that, compared to abled persons, the LF/HF ratio was usually higher in the base measurement. As an illustration, table 1 presents the results of the abovementioned two graphics students.

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[20] J. Zielińska, *Wybrane techniki obrazowania sygnałów w perspektywie pedagogiki specjalnej – przykłady zastosowania w praktyce diagnostyczno-terapeutycznej*, Wydawnictwo Naukowe UP, Kraków 2016, p. 140.

Table 1. LF: HF value. Results for graphics students – the hearing student and the deaf student (Own elaboration)

Test	LF/HF	
	Deaf person	Hearing person
Open eyes	1.64	0.38
Representational paintings	1.83	0.49
Abstract paintings	0.64	1.71
Paintings with strong emotional connotations	1.77	1.02

As table 1 shows, the results for the hearing student do not reflect the measurements typical of that group, as the LF/LH ratio was the highest when she looked at abstract paintings, rather than in the last test. This is probably due to increased activity in the Alpha and Theta bands, balancing the sense of anxiety with curiosity raised by the stimulus and visualisation in the last test, and a slight increase in Beta2 in test III, when the ratio was the highest. On the other hand, a significant increase in the ratio was observed in the deaf person in the last test, and the result was compliant with the measurement of bioelectric brain activity and the sense of fear and anxiety associated with paintings, declared by the student. The lowest ratio was associated with abstract paintings. It is hard to interpret this fact as the test group was limited and the results were very different and individualised[21].

4. Summary and suggestions for practice

The results and conclusions of the tests suggest specific patters of bioelectrical brain activity in persons with hearing impairment during art perception. One of the functions of the brain is to give

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[21] J. Zielińska, *Wybrane techniki obrazowania sygnałów w perspektywie pedagogiki specjalnej – przykłady zastosowania w praktyce diagnostyczno-terapeutycznej*, Wydawnictwo Naukowe UP, Kraków 2016, p. 145.

meaning to the surrounding reality and the signals a person receives. The process is complicated and, confronted with a number of equally justified meanings, a number of different interpretations of a painting are admissible[22]. The phenomenon is called multiple narrative interpretation and it occurs during art perception. As the research on persons with hearing impairment on the borderline of special needs education and neuroaesthetics presented in this article suggests, hearing impairment influences this phenomenon. Thus, it must contribute to the development of a person with hearing impairment as a recipient and creator of art.

Consequently, the results of the research first of all have an important educational dimension. They prove once again that persons with disabilities must be treated in an individual way. The research is preliminary in nature, due to the limited size of the test group of persons with hearing impairment and require a reliable and empirical verification on larger, statistically significant test groups. Subsequent research should also take into consideration the compensatory role of vision in the development and functioning of a person with hearing impairment and the impact of that compensatory mechanism on the neurobiological activity of the brain. Also, the impact of using of hearing aids by a person with hearing impairment, in terms of hearing perception and the acquired linguistic, communicational and social skills, should be considered. These parameters may also influence the neurobiological activity upon contacts with visual arts. Since such research encompasses a number of disciplines, cooperation in research teams comprising multiple fields of science and is needed. This concerns both the planning and implementation phases as well as analysis and interpretation of results. For example, the research results presented in this article, concerning art perception by adults with hearing impairment, should be interpreted not only by deaf educators but also by researchers with relevant knowledge in the field of neuroaesthetics.

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[22] S. Zeki, *Splendors and Miseries of the Brain: Love, Creativity and the Quest of the Human Happines*, Wydawnictwo Wiley-Blacwell, Malden 2008, p. 98.

Bibliography

Cieśla K., *Plastyczność układu słuchowego – badania z zastosowaniem metod neuroobrazowa ni*, „Nowa Audiofonologia" 2013, no. 2(3), pp. 16-23.

J. Cieszyńska, *Od słowa przeczytanego do wypowiedzianego. Droga nabywania systemu językowego przez dzieci niesłyszące w wieku poniemowlęcym i przedszkolnym*, Wydawnictwo Naukowe UP, Kraków 2001, pp. 9–10.

Dryżałowska G., *Rozwój językowy dziecka z uszkodzonym słuchem a integracja edukacyjna: model kształcenia integracyjnego*, Wydawnictwo Uniwersytetu Warszawskiego, Warszawa 2007, p. 50.

Herzyk A., *Mózg, emocje, uczucia. Analiza neuropsychologiczna*, Wydawnictwo UMCS, Lublin 2000, pp. 7-8.

Jegier A., Kosowska M., *Relacje dziecka z wadą słuchu w szkole*, Wydawnictwo Difin SA, Warszawa, 2011, p. 60.

Kobosko J., *Doświadczanie objawów depresji u osób dorosłych z głuchotą prelinwalną korzystających z implantu ślimakowego a sposoby radzenia sobie ze stresem i samooceną*, „Nowa Audiofonologia" 2014, no. 3(1), pp. 34-45.

Orłowska-Popek Z., *Emocje w wypowiedziach uczniów niesłyszących*, Wydawnictwo Naukowe UP, Kraków 2011, pp. 5-7.

Pilch T., Bauman T., *Zasady badań pedagogicznych. Strategie ilościowe i jakościowe*, Wydawnictwo Akademickie „Żak", Warszawa 2001, p. 77-79.

Zborucka A., *Ćwiczenia z surdopsychologii*, Wydawnictwo Naukowe WSP. Kraków 1983, p. 63.

Zeki S., *Splendors and Miseries of the Brain: Love, Creativity and the Quest of the Human Happines*, Wydawnictwo Wiley-Blacwell, Malden 2008, pp. 15-20, 98.

Zielińska J., *Metody obrazowania pracy mózgu w perspektywie pedagogiki specjalnej – wybrane zagadnienia*, Wydawnictwo Naukowe UP, Kraków 2015, p. 32.

Zielińska J., *Wybrane techniki obrazowania sygnałów w perspektywie pedagogiki specjalnej – przykłady zastosowania w praktyce diagnostyczno – terapeutycznej*, Wydawnictwo Naukowe UP, Kraków 2016, pp. 118-119, 133-146.

Netography

http://www.emeraldinsight.com/journals.htm?articleid=1840314 [access: 20.02.2018].

http://www.akademiamedycyny.pl/geriatria/archiwum/201404/201404_Geriatria_004.pdf [access: 18.03.2018].

http://pl.wikipedia.org/wiki/Autonomiczny_uk%C5%82ad_nerwowy [access: 23.03.2018].

http://pl.wikipedia.org/wiki/Emocja [access: 23.03.2018].