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Aetiology of Theory of Mind disorders for people with Autism Spectrum Disorder : Neurocognitivetherapeutic intervention

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AETIOLOGY OF THEORY OF MIND DISORDERS FOR PEOPLE WITH AUTISM SPECTRUM DISORDER. NEUROCOGNITIVE THERAPEUTIC INTERVENTION

INTRODUCTION

The development of neuroscience in the field of cognitive science[1], mainly neurotechnology, enabled a better understanding of how mind operates (correctly and incorrectly), including the neuropsychic functioning, typical for people with Autism Spectrum Disorder. Activity of a living brain is examined with help of electronic, magnetophysiological, and tomography imaging methods (e.g. using a functional magnetic resonance, fMRI), as well as the transcranial magnetic stimulation, TMS)[2]. Techniques of the neuroimaging of the brain, enabling an overview of the structure status and functions of the brain in vivo allow to determine a type and location of the brain's disfunction with high precision. Atypical brains differ substantially from each other in terms of their anatomy.

However, a presence of local developmental disfunctions is incidental, and the direct link between the area of the brain and the type of the neurodevelopmental disorder occurs occasionally. The developmental disorders usually have polygenic and multifocal neuroanatomical basis. The clinical picture of the ASD, both axial symptoms (e.g. abnormal social relations and stereotypical behaviors and interests[3]) and additional somatic and neurophysiological disfunctions, point to the global failure of the central nervous system (CNS).

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[1] Z. Chlewiński, *Psychologia poznawcza w trzech ostatnich dekadach XX wieku*, Gdańsk 2007.

[2] P. Jaśkowski, *Neuronauka poznawcza. Jak mózg tworzy umysł*, Warszawa 2009; A. Pluta, *Mechanizmy poznawcze teorii umysłu*, „Roczniki Psychologiczne" 2012, t. XV, nr 1, s. 7––30.

[3] *Diagnostic and statistical manual of mental disorders. Fifth edition. DSM-5,* American Psychiatric Association, Arlington VA 2013.

If the patient reveals outstanding abilities despite the atypical brain development, they are selective and result from a specific specialization of neurons. This pattern applies to e.g. one of the autism spectrum disorders – Asperger's Syndrome.

According to the leading scholars of the ASD, such as Uta Frith[4], because of the large number of possible malformation causes – functional and structural – the diagnosis of the neurodevelopmental disorders should be multifaceted: biological, cognitive, and behavioral. So far, the diagnosis is usually made according to behavioral indicators. A consequence of this is the greatest popularity of a behavioral and cognitive-behavioral therapy, of course, not downgrading its scientifically proven effectiveness in improving the quality of autistic people's lives[5].

NEUROPSYCHOLOGICAL AETIOLOGY OF ASD

There are many theories explaining the occurrence of autism. However, precise and direct reasons for the disorder's appearance remain unknown. Causes of autism as a neurodevelopmental disorder with a complicated and complex aetiology, are believed to have their roots in biological factors, primarily in genetic predispositions, but also in environmental conditions. The genetic determinants are confirmed by, amongst others, a higher incidence of autism in boys and monozygotic twins, as well as a genealogical research[6]. There are several attempts to locate genes and the environmental factors responsible for pre – and postnatal development of an "autistic" brain. It has not been established yet what genes, what number and localization of them is necessary or sufficient for the development of autism. Research suggests from 2 to 10 genes arranges randomly[7] and reveals anomalies of neurons' microstructure within the white and graymatter of the autistic people's brains.

Because there is no confirmation from empiricists' side, nowadays a purely psychogenic substrate of autism is eliminated. Psychological theories of autism have been replaced by neuropsychological concepts describing and explaining the mechanisms of the ASD people's functioning. These theories

[4] U. Frith, *Autyzm. Wyjaśnienie tajemnicy*, Sopot 2015.

[5] M. Suchowierska, P. Ostaszewski, P. Bąbel, *Terapia behawioralna dzieci z autyzmem. Teoria, badania i praktyka stosowanej analizy zachowania*, Sopot 2015.

[6] U. Frith, op.cit.

[7] E. Pisula, *Autyzm. Od badań mózgu do praktyki psychologicznej*, Sopot 2015.

focus on the psychological consequences, mainly cognitive processes, the structure of a damaged central nervous system (brain lesions), and impaired functions, e.g. mirror neurons. These theories include the concept of an impaired theory of mind, which is the subject of reflection of the present study.

THEORY OF MIND (TOM)

The Theory of Mind is one of the key issues of contemporary cognitive and social neuropsychology. The concept of this theory refers to people's awareness of their thinking and their ability of reading the mind (mindreading). The Theory of Mind is a concept that consists of two components: "metacognition – an individual's knowledge about his or her cognitive processes and knowledge of the minds of others, and metaabilities – ability to use this knowledge in relationships with others and themselves. These abilities serve for a self-regulation –the use of possessed knowledge and abilities in a specific cognitive and emotional situation"[8]. The function of the Theory of Mind mechanism is to create an idea of other people's minds that, according to Simon Baron-Cohen, provides flexible and effective interpretation of social behaviors[9].

Theory of mind is an intuitive ability to create mental representations relating to states of other people's minds, and to identify their psycho-cognitive, emotional-motivational, and awareness experiences. In other words, it is the ability to assign and explain unobservable mental states: beliefs, emotions, desires, understanding of intentionality. In its character, the Theory of Mind is a naive psychological theory, i.e. it constructs the model used to explain and to predict the behavior of oneself and other people in an individual's mind. The Theory of Mind allows self-reflection, a sense of identity, self-awareness, building an image of the self, understanding metaphors, jokes, lies, but also cooperation, competition and cheating.

In many modern views the Theory of Mindis identified with metacognitive consciousness as a metacognition, which consist of three components: metacognitive knowledge, metacognitive experiences, and metacognitive

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[8] M. Karwowska-Struczyk, *Zrozumieć dzieci – teorie umysłu w pracy metodą projektów*, [in:] M. Sieńczewska (ed.), *Razem poprzez zmiany w kształceniu praktycznym przyszłych nauczycieli*, Warszawa 2014, p. 36.

[9] S. Baron-Cohen, *Rozwój zdolności czytania innych umysłów: cztery etapy*, [in:] A. Klawiter (ed.), *Formy aktywności umysłu. Ujęcia kognitywistyczne. Ewolucja i złożone struktury poznawcze*, Warszawa 2009.

skills. The metacognitive skills are also called metacognitive strategies, or metacognitive abilities to control[10]. Synonymously the Theory of Mind is determined as a metacognitive self-regulation, the mindreading, naive theories of mind, mentalizing, mental attribution, reasoning about mental states, knowledge of the mind, making attributions on the mental states of others[11].

There are many psychological explaining the mechanism of the Theory of Mind. Sometimes the criterion differentiating theories is the way of considering the nature of the Theory of the Mind as a purely cognitive, or social-communication-cognitive skill[12]. The concept of the cognitive development of the Theory of Mind includes the theory of the innate modules by Simon Baron-Cohen[13] and Uta Frith[14], the theory theory by Henry Wellman, the theory of embodied simulation by Vittori Gallese, and the theory of imitation by Andrew Meltzoff[15]. The social-communication-cognitive approach is represented by the theory of the shared intentionality by Michael Tomasello, the theory of human pedagogy by György Gergely, the concept of the development of social understanding by Jeremy Carpendale and Charlie Lewis, and the concept of entering the community of minds by Katherine Nelson[16].

Theoretical models explaining the Theory of Mind are often divided into the ones that treat the Theory of Mind as a "selective cognitive ability, specialized in processing of information about the mental states (domain-specific processes)" and the ones that assume that the Theory of Mind "participates in the creation of different types of metarepresentation and depends on other cognitive processes, e.g. executive functions, language (domain-general processes)"[17].

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[10] M. Dragan, W.Ł. Dragan, *The Metacognitions Questionnaire-30 Psychometric properties of the Polish version of the Metacognitions Questionnaire-30*, "Psychiatria Polska" 2010, 45 (4), p. 545–553.

[11] A. Pluta, op.cit.

[12] M. Białecka-Pikul, *Narodzimy i rozwój refleksji nad myśleniem*, Kraków 2012.

[13] S. Baron-Cohen, op.cit.

[14] U. Frith, op.cit.

[15] A. Putko, *Dziecięca teoria umysłu w fazie jawnej i utajonej a funkcje wykonawcze*, Poznań 2008.

[16] M. Białecka-Pikul, op.cit.

[17] A. Pluta, op.cit., p. 4.

THE DEVELOPMENT OF THE THEORY OF MIND MECHANISM (TOMM)

The Development of *the Theory of Mind Mechanism* (ToMM)[18] begins in early childhood. Reading elementary intentions of the closest caregivers appears to be innate, starting from the awareness of other people's existence, which is present in infants. The awareness of the fact that mental states of other person may not equate with their own states, and that they may even differ from the actual state, develops between third and fourth year of life. Many researchers have considered a child's understanding of the possibility of other people having false, erroneous beliefs as a sufficient evidence of the child's metacognitive awareness[19]. Empirical studies indicate that this ability, along with the development of executive functions, is reached at about the age of four. However, perhaps younger children are able to use the theory of mind, but it is undisclosed by the experimental procedure used as part of the developmental psychology. On the other hand, according to some psychologists, "only the children's understanding of ambiguity allows to say that they are aware of the interpreting and active role of their minds in exploring the world"[20]. The ability to use this mental structure, called the interpretive theory of mind, emerges slightly later – between fourth and fifth year of life[21].

NEUROANATOMICAL IN EURO FUNCTIONAL CORRELATES OF THE ATOM

The results of the research in clinical neuropsychology suggest the dominance of the so-called ToM net location in the right hemisphere and, therefore, serious theory of mind dysfunction with the damage of the right hemisphere. The brain areas showing increased activity during the mindreading (mind reading system), which is specialized in the processing of information about the mental states of others, are the right and left temporoparietal junction, dorsal medial prefrontal cortex, posterior cingulate, and the preconeus[22].

18 S. Baron-Cohen, op.cit.

19 M. Białecka-Pikul, op.cit.

20 Ibidem.

21 M. Reuter, *Rozwój teorii umysłu u dzieci – uwarunkowania neurobiologiczne i społeczno-kulturowe, Annales Academiae Medicae Stetinensis. Neurokognitywistyka w patologii i zdrowiu*, Szczecin 2013.

22 A. Pluta, op.cit.

The structure of the neuronal network responsible for the theory of mind is formed at the age of six. Until late childhood, from tenth to twelfth year of life, developmental changes of the functional specialization of the brain areas responsible for the ToMM occur[23].

A neurophysiological substrate of the theory of mind is most likely stated by multimodal neurons – the mirror neurons. Their main clusters are located in the motor cortex of the frontal lobe and the parietal lobe. The mirror neurons are responsible for reading of facial expressions, intentions, intentions of another people, the ability to imitating, common attention, compassion. Thanks to them a chameleon effect is possible, meaning "a tendency to mutually imitate the behaviors of individuals in social interaction"[24]. When the chameleon effect appears, the partners in a relationship have a sense of good contact and are willing to empathise. It is reported that people with ASD have a decreased activity of the mirror neurons in the lower frontal gyrus, in the insular and frontal braincingulate cortex[25].

NEUROPSYCHOLOGICAL DIAGNOSIS OF THE TOMIN PEOPLE WITH THE ASD

In 1985, Simon Baron-Cohen, Alan M. Leslie and Uta Frith[26] described a developmental disorder of cognitive abilities, which constitute the theory of mind as the basic neuropsychological cause of autism. People with ASD exhibit defective development of the theory of mind. The results of empirical studies suggest that about 70–80% of children with autism do not use the ToM[27]. The remaining 20–30% has only the ability to understand the desires, emotions and intentions of others. They do not reveal more complex forms of the theory of mind – second-order beliefs, or the ability of metathinking and recognition of cognitive emotions demanding the creation of complex forms of secondary representations, e.g.: "Mom thinks that Dad has already guessed that my younger brother is afraid of swimming".

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23 M. Reuter, op.cit.

24 P. Jaśkowski, op.cit., p. 245.

25 E. Pisula, op.cit.

26 S. Baron-Cohen, A. Leslie, U. Frith, *Does the autistic child have a theory of mind?*, "Cognition" 1985, nr 21 (1), p. 37–46.

27 E. Pisula, op.cit.

In the process of diagnosing the ASD, a neuropsychological evaluation of the theory of a patient's mind can be included. Observational precursors of the ToM deficit may be the absence of the sight direction detector, indicating gestures, joint attention, and pretend plays. Among others, these elements are the basis of the Modified Checklist for Autism in Toddlers (M-CHAT) by Diana Robins, Deborah Fein and Marianne Barton[28], applied from 18th month of a child's life. In the middle childhood stage, the ToM research tools are usually false belief tests[29], such as Unexpected Transfer Task, Deceptive Box Test, and Appearance-Reality Task. Occuring errors of, e.g. phenomenalism, or realism in a children's thinking shall be interpreted properly as indicators of an impaired theory of mind. Apart from the false belief paradigm, the study of children's ability to read the mental states as reasons for other peoples behaviors are also carried using a procedure of a metaphors test[30]. A good way to learn the state of the theory of mind is also an honest and planned observation of the child in natural, everyday situations.

A neurophysiological index of a theory of mind deficit is the incorrect operation of the mirror neurons. Symptoms of the lack, or malfunctioning of the mirror neurons coincide with clinical symptoms of autism. The activity of the mirror neurons of a healthy person observing another person performing an action, evinces a suppression of one of brain waves type – the rhythm μ[31]. Experiments using the technique of electroencephalography (EEG), magnetoencephalography (MEG), and transcranial magnetic stimulation (TMS) revealed a lack of wave μ suppression, or an impaired operation of the mirror neurons in people with autism. An ability to diagnose the lack of the μ wave suppression with different brain neuroimaging methods can serve early detection of autism threat.

THE IMPLICATIONS FOR THE NEUROPSYCHOLOGICAL THERAPY

The so-called *soft neurology*, unlike neurology dealing with the treatment of structural damage, aims at correction of functional developmental abnormal-

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[28] D. Robins, D. Fein & M. Barton, *The modified checklist for autism in toddlers, revised (M-CHAT-R/F) TM,* 2009.

[29] M. Białecka-Pikul, op.cit.

[30] Idem, *Krytycznie o sposobach badania teorii umysłu. Dziecięce strategie radzenia sobie z rozumieniem stanów mentalnych na materiale metafor*, „Psychologia rozwojowa" 2007, nr 12(1).

[31] V.S. Ramachandran, *Neuronauka o podstawach człowieczeństwa. O czym mówi mózg?*, Warszawa 2012.

ities resulting from an undeveloped central nervous system, or its disfunction. In the treatment of autism spectrum disorders, e.g. children's autism, atypical autism, Asperger's Syndrome, etc., cognitive therapies are introduced. They are based on the interaction of different specialists: a neurologist, pediatrician, psychiatrist, psychologist, special needs teacher, sensory integration therapist, speech therapist, physiotherapist, and a computer scientist.

There are many cognitive therapeutic techniques for reduction of intellectual processes', communicative (particularly speech), emotional-motivational, motor, and, as a result, social deficits[32]. Cognitive therapies are methods for supporting development by influencing the work of the central nervous system. They interact therapeutically, stimulating and/or educationally. They rely on a cognitive stimulation, primarily thinking. The therapeutic techniques help reduce anxiety, speech disfunctions, disorders of perception and memory, difficulties in learning, reading, concentration, coordination, and balance. Patients exhibiting neuromotoric immaturity are involved in health/preventive programs.The used therapies include a training of the theory of mind, EEG neurofeedback, A.A. Tomatis's method, SI therapy, NDT-Bobath, Vojta's method, sequential-simultaneous method by J. Cieszyńska, NPP P. Blythe, a method of the good start by M. Bogdanowicz, and a method of the developmental movement by V. Sherborne.

The basic criterion for the selection of the therapy is its effectiveness – objectively, according to the principles of a scientific inquiry – the measured clinical result of the method[33]. In 2014, a report of National Autism Center came out in the USA, and in 2015 a report entitled The evidence-based practice of therapy of people with ASD. In these records, methods of supporting of the development were divided into three groups: interventions established, promising, and never established. The interventions established, for which

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[32] M. Prentka, *Funkcjonowanie społeczne, intelektualne i emocjonalne dzieci ze spektrum autyzmu we współczesnym społeczeństwie*, [in:] H. Czakowska, M. Kuciński (ed.), *Idea wielokulturowości jako wyzwanie. Dyskurs religijny, kulturowy i społeczny*, Bydgoszcz 2015; Eadem, *Kognitywistyczna terapia całościowych zaburzeń rozwojowych metodą Integracji sensorycznej*, [in:] M. Prentka (ed.), *Wspomaganie rozwoju osób z zaburzeniami ze spektrum autyzmu. Terapie kognitywistyczne*, Bydgoszcz 2016 (w druku).

[33] E. Pisula, *Kontrowersje wokół stosowania kinezjologii edukacyjnej w terapii dzieci z autyzmem*, [in:] K. Korab, R. Borowiecka, E. Petrykiewicz (ed.), *Kinezjologia edukacyjna. Nauka, pseudonauka czy manipulacja?*, Warszawa 2008; T. Witkowski, *Zakazana psychologia. Nauka kultu cargo i jej owoce*, Warszawa 2013; idem, *Zakazana psychologia. Pomiędzy nauką a szarlatanerią*, Wrocław 2015.

there is evidence of a positive impact on the functioning of people with ASD, are primarily behavioral and cognitive-behavioral interventions, but also language training – production, moderating – live and videomoderating, training of parents and peers, training of key skills, training of independence and the self-control, as well as the social skills training. The promising interventions, having too little evidence of efficacy, include the theory of mind training, tools of supporting and alternative communication, exposition therapy, functional communication training, language training – production and comprehension, massage therapy, and music therapy. The interventions not raised, or those for which there is no evidence, which are contradictory, or there is evidence of their harmfulness, are: animal-assisted therapies, training aids, Floortime, facilitated communication, gluten-free and casein-free diet, movement-based interventions – choreotherapy and Dennison's method, drama-based interventions, the SI therapy method, and an electroconvulsive therapy.

There is a variety of cognitive trainings of the ToM[34], e.g. intervention programme "How to teach mindreading to autistic children"[35], social or comic stories[36], and social-cognitive traing of the ToM by PimSteerneman "Study of thinking about thinking and understanding emotions"[37]. People who undergo a therapy progressively develop skills of simple and complex taking perspective of someone else, understanding first true, and then false beliefs, and eventually assimilating the second-order beliefs, that is, involving the understanding that one person might wonder what other person is thinking and the ability to use it to predict the behavior of others.

The cognitive therapy of building a theory of mind disfunctions by people with autism corresponds with Vilayanur S. Ramachandran's[38] proposal of an activation of the mirror neurons by reducing the μ signal. The study of μ waves suppression with the neurofeedback can be used as a behavioral prophylaxis for people at risk of autism, as well as a therapeutic intervention for ASD. The *neurofeedback* is a neuropsychotherapy in form of a visualization; it is an

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[34] B. Winczura, *Dziecko z autyzmem. Terapia deficytów poznawczych a teoria umysłu*, Kraków 2008.

[35] P. Howlin, S. Baron-Cohen, J. Hadwin, *Jak uczyć dzieci z autyzmem czytania umysłu*, Kraków 2011.

[36] C. Gray, *Nowe historyjki społeczne. Ponad 150 historyjek, które uczą umiejętności społecznych dzieci z autyzmem, zespołem Aspergera i ich rówieśników*, Gdańsk 2014.

[37] V.S. Ramachandran, op.cit.

[38] Ibidem.

autogenic training using the EEG. It is based on the principle of feedback, or giving the patient a information about the functionality or disfunctionality of a bioelectrical activity of his brain.

The person subjected to the *neurofeedback* observeshis or her own bioelectrical activity of the brain in form of a video game on a screen. The person tries to control the game by concentrating. The therapist, during the training, promotes ranges of bioelectrical activity that are beneficial for the patient. The patient tries to learn and memorize these states of the brain activity which are positively reinforced by a visual and auditory stimulus. The use of the *neurofeedback* techniques based on, e.g. playing a computer car race, where muting the μ rhythm is rewarded, makes an achievement of a gradual control of the brain possible. It refers, e.g. to boys with the Asperger's Syndrome[39]. The measurement of the μ waves suppression after the training cycle finish, can be considered as an objective indicator of the treatment's efficacy.

CONCLUSIONS

Understanding the Theory of Mind of people with ASD depends on the condition of the Theory of Mind of people dealing with them, both scientists and therapists. Since the knowledge about the psyche of people with ASD determines the quality of the given aid, alleviation of sufferings, and supporting the development, it is worth expading and continuing research.

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[39] M. Prentka, *Kognitywistyka w służbie wspomagania rozwoju osób z autyzmem (Wstęp)*, [in:] M. Prentka (ed.), *Wspomaganie rozwoju...*, op.cit.

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SUMMARY

Psychological theories of autismhavebeenreplaced by neuropsychological concepts describing and explaining the mechanisms of the ASD people's functioning. These theories focus on the psychological consequences, maliny cognitive processes, the structure of a damaged central nervous system (brainlesions), and impaired functions, e.g. mirror neurons. These theories include the concept of animpaired theory of mind, chich is the subject of reflection of the prezent study. Theory of mind is an intuitive ability to create mental representations relating to states of Rother people's minds, and to identify their psycho-cognitive, emotional-motivational, and awareness experiences. People with ASD exhibit defective development of the theory of mind. The results of empirical studiem suggest that about 70–80% of children with autism do not use the ToM. In the process of diagnosing the ASD, a neuropsychological evaluation of the theory of a patient's mind can be included. A neurophysiological index of a theory of mind deficitis the incorrect operation of the mirror neurons. Experiments using the technique of electroencephalography (EEG), magnetoenceph-

alography (MEG), and transcranial magnetic stimulation (TMS) revealed a lack of wave μ suppression, Or animpaired operation of the mirror neurons in people with autism. An ability to diagnose the lack of the μ wave suppression with different brain neuroimaging metod scan serve early detection of autism threat. The cognitive therapy of building a theory of mind disfunctions by people with autism corresponds with Vilayanur S. Ramachandran's proposal of an activation of the mirror neurons by reducing the μ signal. The study of μ waves suppression with the neurofeedback can be used as a behavioral prophylaxis for people at risk of autism, as well as a therapeutic intervention for ASD.

Key words: Theory of Mind, Autism Spectrum Disorder, neurocognitive diagnosis & therapeutic intervention, neurofeedback, μ waves.

ETIOLOGIA ZABURZEŃ TEORII UMYSŁU U OSÓB Z ZABURZENIAMI ZE SPEKTRUM AUTYZMU. NEUROPOZNAWCZA INTERWENCJA TERAPEUTYCZNA

STRESZCZENIE

Psychologiczne teorie autyzmu zostały zastąpione koncepcjami neuropsychologicznymi, opisującymi i wyjaśniającymi mechanizmy funkcjonowania umysłów osób z zaburzeniami ze spektrum autyzmu. Teorie te koncentrują się na psychologicznych konsekwencjach, głównie procesach poznawczych, uszkodzonej struktury OUN i zaburzonej funkcji neuronów lustrzanych. Należy do nich koncepcja zaburzonej teorii umysłu, będąca przedmiotem refleksji prezentowanego opracowania. Teoria umysłu to intuicyjna zdolność tworzenia reprezentacji umysłowych odnoszących się do stanów umysłu innych ludzi, rozpoznawania u nich przeżyć psychicznych – poznawczych, emocjonalno-motywacyjnych i świadomościowych. Osoby z ASD przejawiają defekt rozwoju teorii umysłu. Wyniki badań empirycznych sugerują, że 70–80% dzieci z autyzmem nie posługuje się ToM. W proces diagnozowania ASD można włączyć neuropsychologiczną ocenę teorii umysłu pacjenta. Neurofizjologicznym wskaźnikiem deficytu teorii umysłu jest nieprawidłowa praca neuronów lustrzanych. Eksperymenty przy użyciu techniki elektroencefalografii (EEG), magnetoencefalografii (MEG), przezczaszkowej stymulacji magnetycznej (TMS) ujawniły brak tłumienia fal μ – czyli zaburzoną pracę zwierciadlanych neuronów u osób z autyzmem. Możliwość diagnozowania różnymi technikami neuroobrazowania pracy mózgu braku tłumienia fal μ może służyć wczesnej wykrywalności zagrożenia autyzmem. Z terapią poznawczą dysfunkcji budowania teorii umysłu przez osoby z autyzmem koresponduje propozycja Vilayanura S. Ramachandrana aktywowania neuronów lustrzanych poprzez zmniejszenie sygnału μ. Nauka tłumienia fal μ przy użyciu techniki neurofe-

edbacku może posłużyć jako behawioralne działanie profilaktyczne dla osób zagrożonych autyzmem, a także jako interwencja terapeutyczna dla osób z ASD.

Słowa kluczowe: spektrum autyzmu, teoria umysłu, neuropsychologiczna diagnoza i terapia, neurofeedback, fale μ.