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A Comprehensive Model of Neuropsychological and Speech Assessment for Children with ASD

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Abstract

Modern scientific projects connected with autism spectrum disorders (ASD) study the difficulties in differential diagnosis of ASD and other types of developmental dysphasia, issues of cognitive and physical development of children with ASD, formation of trajectories for their individual and group education and training, their social integration. The relevance of the study is explained by the necessity to work out a system of medical, psychological, linguistic and educational support for children with ASD corresponding to the modern requirements of society and global practices.

The aim of the research is to develop a comprehensive model of neuropsychological assessment and study of speech development for preschool children with ASD. This model assumes the implementation of a) the Russian-language version of the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP), b) the Russian-language version of the BVL battery for speech assessment (BVL_RU), c) traditional for Russia approaches to the diagnosis of developmental disorders and speech impairment. The platform for the project is the kindergarten of Kazan Federal University "We are together".

The comprehensive model includes a new methodological framework, which implements the achievements of cognitive sciences, neuropsychology and neurolinguistics in interdisciplinary fields. The results of the research can be implemented into the practice of teaching preschool children with ASD and become the basis for the further development of this comprehensive model for schoolchildren with ASD.

Keywords: autism spectrum disorders, speech assessment, VB-MAPP, neuropsychological assessment, speech disorders, neurolinguistic battery, BVL_RU, kindergarten.

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Introduction

During last decades the increasing prevalence of autism spectrum disorders (ASD) has been actively discussed. According to Autism and Development Disabilities Monitoring Network ASD prevalence has increased 178% since 2000. Despite the fact that the entire percentage of growth is not always possible to explain, most of the scientists agree that it is the heterogeneity of the ASD that determines the following: the border between presence and absence of this state is very blurred and, as a result, it leads to incorrect diagnosis. ASD are studied in various aspects: neuroanatomical (Sussman et al., 2015; Zuo, Wang, Tao, & Wang, 2019), differential diagnosis with other types of developmental disabilities (including speech pathology) (Conti et al., 2020; Coburn & Williams, 2020; Swanson, 2020), neuropsychological (Rosello, Berenguer, Baixauli, García & Miranda, 2020; Skogli, Andersen & Isaksen, 2020) and physical (Caldani, Baghdadi, & Moscoso, 2020) development of children with ASD, problems of educational and social integration (Bentenuto, Bertamini, Perzoli, & Venuti, 2020; Shabani, 2020). Speech disorders are not the mandatory components of ASD, they are not included into the diagnostic criteria for ASD, however, in most cases, they are central in the structure of this pathology and most impede cognitive development, adequate communication and socialization (Tek et al., 2014; Kwok, Brown, Smyth, & Cardy, J.O. 2015, etc.). Marini underline that speech in children with ASD should obligatory be accessed comprehensively, from microlinguistic and macrolinguistic perspectives (Marini, 2020), La Valle points at the importance of analyzing multidisciplinary aspects of pragmatic communication (La Valle, Plesa-Skwerer & Tager-Flusberg, 2020).

Purpose and objectives of the study

Individuals with ASD need a system of education at all levels (preschool, primary, secondary, higher) corresponding to the modern requirements of society and global practices (Bürki et al., 2021; Johora, Fleer & Hammer, 2021). Thus, the issue of timely diagnosis and overcoming speech disorders becomes one of the leading during continuous complex (medical, psychological, pedagogical, and linguistic) support of children with ASD, as well as best practices broadcast. This causes the necessity to develop an integrated model including neuropsychological assessment and study of speech development designed especially for children with ASD.

Literature review

One of the most famous internationally used programs for cognitive assessment and habilitation of children with ASD is Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP).

The VB-MAPP developed by Sandberg in 2008 combines procedures and methods of Applied Behavior Analysis (ABA) which is constructed on the principles of manipulating consequences using reinforcement and stimuli preceding the behavior. Nowadays ABA is a scientific discipline that makes it possible to study the child's behavior, objectively measure and describe it, determine the cause of unacceptable behavior and draw up a reasonable plan for correction (Nigmatullina & Nigmatullina, 2020).

An extensive meta-analysis of researches on the effectiveness of ABA therapy in treating ASD has been conducted in the United States. Its aim was to provide a thorough and up-to-date assessment of behavioral interventions effectiveness. For the analysis, there were selected publications of 29 studies conducted from 1987 to 2017. They compared the indicators of cognitive development, verbal, non-verbal, adaptive behavior before and after behavioral therapy. The results showed that ABA therapy is a highly effective tool in working with preschool children with ASD (Pennefather, 2018). Today, the use of functional behavioral assessment is included in the professional standard of American specialists and educators who use ABA in rehabilitation of adults and habilitation of children with disabilities. In 1997, the US Congress passed the Individuals with Disabilities Education Act according to which functional assessment of behavior became the professional standard of specialists working with ASD. In 2020, the Russian Ministry of Health approved new clinical guidelines, which will start functioning in 2022, defining recommendations for helping children with ASD, and ABA therapy is included into the list of effective intervention programs in accordance with the requirements of the Center for Expertise and Quality Control of Medical Care (<https://autism-frc.ru/autism/library/341>).

At present, a large number of scientific works are connected with the study of the procedures for assessing speech status and social interaction in children with ASD presented in the VB-MAPP program. According to Padilla, about 80% of ABA specialists report using VB-MAPP (Ackley, Subramanian, Moore, Litten, Lundy, & Bishop, 2019; Padilla, 2020). The study of Padilla and Akers (2021) dedicated to proving the validity of the VB-MAPP program content presents the results of the work of 13 experts. The review team assessed the relevance of the subject area, the appropriateness of age, of the measurement method, and the representativeness of the subject area at three levels of milestone assessment, early echo skills assessment (EESA) and barriers assessment. The results showed that overall, evidence for the validity of content for assessing VB-MAPP, EESA milestones and barriers was moderate or strong across all areas assessed, although there were areas with limited or conflicting support. The authors suggest that social skills assessment by VB-MAPP provide information related to target behaviors, but some areas may not be comprehensively represented by their specific elements (Padilla & Akers, 2021).

The validity of VB-MAPP is discussed by Byrne, Rehfeldt and Aguirre (2014), the effectiveness of the procedure for observing the combination of stimuli, by Brodhead, Higbee, Gerencser and Akers (2016) – using the procedure for teaching discrimination of children with ASD, by Carnett and Ingvarsson (2016), Contreras and Betz (2016), by Gevarter and others (2016) methods of teaching children with the help of VB-MAPP.

The process of developmental therapy for children with ASD requires using specialized batteries of neurolinguistic assessment which would make it possible to track the effectiveness of habilitation in dynamics and compare the results with the data obtained in a sample of neurotypical children. Such tools are used in international practice. For example, “Batteria per la Valutazione del Linguaggio in bambini dai 4 ai 12 anni” (Marini, Marotta, Bulgheroni & Fabbro, 2015; BVL_4-12) is a new neurolinguistic battery which is characterized by valid psychometric properties and theoretical basis. It was worked out in Italy for children from 4 to 12. BVL_4-12 is used also for children with ASD (Marini, 2020). It has versions in other languages (Spanish, Slovenian, German) which make it possible to compare speech status of different monolinguals and bilinguals from a cross-linguistic aspect. There is a Russian-language version of this battery, created and validated at the University of Udine and Kazan Federal University (Marini, Eliseeva, Gorobets & Filippova, 2017).

For neuropsychological assessment of children with ASD different instruments are used, i.e. NIH Toolbox (Solomon et al., 2021), Tower of London (ToL) test and the Wisconsin Card Sorting Test (WCST), etc. The number of tests is great, but predominantly they are not comprehensive, and there are no Russian-language versions of neuropsychological batteries which could be implemented in the process of habilitation at the nearest time. In Russia the most widely spread and well-known instrument of neuropsychological assessment is the methodology of Akhutina and others (Moscow State University) which is built on Luria’s ideas of three functional blocks of brain. Akhutina worked out and standardized the methodology for neuropsychological assessment of children from 6 to 9 years old (2016). It assesses the energetic block of brain, functions of analyzers (auditory-speech, visual, visual-spatial, skin-kinesthetic), functions of programming, regulation and control of voluntary movements and actions. At Kazan Federal University there were conducted comprehensive models of neuropsychological and speech assessment for children and adolescents from 4 to 18 years old (5 age groups) (Gamirova, Gorobets, Akhutina & Esin, 2019). They are based on the principles of neuropsychological diagnostics developed by Akhutina according to Luria’s approach which includes qualitative assessment and quantitative psychometric analysis, and linguistic validation of verbal stimuli.

The tests include a large number of variants – equal in complexity material in order to avoid repetition in diagnostic process; comprehensive study of speech (phonological, lexical, derivational, morphological, grammatical, discourse, pragmatic analysis).

Methodology

The methodological principles are aimed at the development of new trends in personalized education and personalized medicine, one of the main tasks of which is the study of higher mental functions development. The comprehensive model assumes the implementation of traditional for Russia approaches to the diagnosis of developmental disorders and speech impairments and a new interdisciplinary approach based on current achievements of neuropsychology, cognitive sciences, clinical linguistics, neurology, psychiatry, which provides the necessary depth of analysis. The comprehensive model of treating children with ASD at the kindergarten of Kazan Federal University "We are together" involves medical, psychological, linguistic and educational support. It includes methods of neuroimaging (magnetic resonance imaging) and functional diagnostics (video-EEG monitoring with sleep deprivation), periodic examinations of neurologists and psychiatrists during habilitation. Neuropsychological and speech assessment involves the Russian-language version of VB-MAPP used in ABA therapy for children with ASD, as well as traditional Russian-language instruments, the BVL_RU battery (Marini et al., 2017) – the Russian-language version of the BVL_4_12 battery, which is currently translated into Russian, passed the procedure of linguistic validation and is undergoing the procedure of standardization on a Russian-speaking sample of informants, which will create a platform for further comparative population studies, since the tool is already implemented in several languages and in children with ASD (Marini, 2020).

Results

VB-MAPP. The procedure for assessing a child's skills is a mandatory step in designing an intervention program. The ABA program is always developed individually, and the choice of the program goals depends on the skills of the child and their level in comparison with typically developing children: understanding of speech, communication, playing, reading, counting, imitation, intraverbal skills, motor skills. The advantage of this diagnostic tool is that it allows specialists to determine the baseline level of each child with developmental disabilities, since each of the parameters for assessing the stages of development is considered separately. Unlike most diagnostic techniques, VB-MAPP is based not only on the functional assessment of the child's social skills, but also on their functional analysis.

The combination of these methods provides the selection of effective tools for building a program of habilitation, to track the dynamics of the development. The VB-MAPP includes the following assessment criteria: Milestone Assessment, Barriers Assessment, and Transition Assessment.

The assessment of developmental milestones includes a functional assessment of the current level of pre-speech, speech, social and cognitive skills of the respondents according to 170 parameters, which are distributed in three age groups and correspond to the level of normative development of a child aged from 0 to 18 months, from 18 to 30 months and from 30 to 48 months. The diagnosed skills include: the skill of request (mand), the skill of spontaneous naming of objects (tact); speech perception skill (listener skill); the ability to imitate movements (motor imitation); features of auditory perception and sound imitation (echo reaction); playing skills; social skills; visual perception; features of speech development (linguistic structure of speech); the ability to generalize and differentiate (the skill of distinguishing by functions, characteristics and categories); the ability to enter into verbal contact (intraverbal skills); social behavior skills (group behavior skills) and academic skills (reading, math, writing). The skills are tested in the sequence in which they are specified in the test headings.

After the assessment of each development milestone, the form "Assessment of development milestones" of the VB-MAPP protocol is filled out. Skill assessment is carried out using four methods: formal testing, observation, a combination of formal testing and observation, and time-limited observation. If the child's scores relate mainly to level 1, then the main activities in the intervention will be aimed at the formation of six main speech and speech-related skills: mand, echo, motor imitation, listener behavior, visual perception and matching skills. Play and social skills should also be included in the intervention program.

If the development of speech and speech-related skills corresponds to level 2 in the VB-MAPP diagnosis, then the child is still at an early stage of learning, but at the same time he/she has formed some stable speech and academic skills. At this stage, the proportion of training in the natural environment is gradually increasing in comparison with the level 1.

The third level presents mature educational behavior and stable basic academic skills. Its beginning corresponds to the age of about 30 months, when typically developing children master hundreds of mandate reactions, tact and listener behavior, and also easily learn new words. The development of important speech and social skills at this stage occurs in the natural environment (at home, with peers, in groups). An important area of work for children who have reached the third level is the integration into the peer environment for the further development of his/her social skills, tact and intraverbal skills.

The Barriers Assessment is designed to identify and measure learning and language difficulties that hinder child development, and as a result, difficulties in learning skills. In this section, 24 areas are subjected to functional assessment in order to determine which particular obstacles prevent the child from learning effectively. During the functional assessment, points are set on the criterion developed by the author for each of the obstacles according to Likert scale. A detailed descriptive and functional analysis of the difficulties should be performed, which will identify effective strategies and directions for the development of a more highly specialized, taking into account the characteristics of a particular child, program of habilitation. The Transition Assessment is intended to objectively assess the skills of the child as a whole and the current learning ability. The author of this methodology identifies three main categories of skills. The first category covers the child's speech and social skills, academic independent activities and existing barriers that hinder the child's learning. The second category describes a child's specific learning patterns that include information about the ability to acquire new knowledge and skills outside of an intensive, detailed structured learning format. The third category concerns the skills of self-help, spontaneity and self-reliance. The importance of this section is determined by the difficulty of defining an effective educational environment and form of education; the possibility of transferring a child from an intensive program of correctional work to a general educational environment together with normo-typical peers for a full day or part of the time.

At the third level according to VB-MAPP classification it is possible to implement Russian-language instruments of neuropsychological and speech assessment which are used in Russia nowadays.

For cross-linguistic studies, the BVL_RU is the most appropriate battery to be implemented as BVL_4_12 is one of the neurolinguistic instruments that has already been used for speech assessment in children with ASD (Marini, 2020). BVL_RU contains three types of subtests which assess oral speech: a) production skills; b) comprehension skills; repetition skills.

Production skills are assessed by subtests evaluating a) phonetic, b) lexical, c) sentential and d) narrative discourse production. Lexical skills are assessed by subtests of *naming and articulation* (age 4–6.11), *naming* (age 7-12). They help to estimate the level of selecting a target lexical unit in mental lexicon, lexical access and production skills. A *semantic fluency* subtest determines the ability to choose target words from specific semantic categories. Similarly, a *phonological fluency* subtest measures the ability to use a phonological strategy, to inhibiting incorrect words and select only that on which is adequate to the instruction. A *sentence completion* subtest evaluates the child's fluency in derivation and morphological aspects of language.

A *narrative discourse production* subtest gives an opportunity to conduct a multilevel analysis of speech and to assess the narrative discourse. As a result we can assess child's productivity, lexical processing, grammatical and discourse processing, as well as functional informativeness.

Comprehension is assessed by subtests evaluating a) metaphonological, b) lexical, c) grammatical, d) pragmatic and e) prosodic (linguistic and emotional) comprehension: *phonological discrimination* (ability to recognize phonologically identical words and discriminate between pairs which one different sound), *lexical comprehension* (selection which of 4 visual stimuli represents better the target word given orally; one of the stimuli is target, other are distractors – a) semantic, b) phonologic and e) unrelated distractor), *grammatical comprehension* (understanding of the meaning of several syntactic units with varying length and structure); *grammatical judgment* (definition of grammatical acceptability of syntactic structures with variable length and syntactic complexity); *comprehension of idioms, linguistic prosody* (recognizing a statement, a question, or an order), *emotional prosody* (evaluates the child's ability to recognize the emotional connotation of speech), which is especially important for children with ASD as these subtests are connected with rather subtle communicative aspects of speech.

Oral repetition skills. It is presents by subtests evaluating the child's ability to repeat existing in the language words, legal non-words and sentences with different syntactic structure: a) *word repetition* (15 words with increasing syllabic length; b) *non-word repetition* estimates the ability to correctly process and repeat sequences of phonemes that do not relate to words existing in their language (Velichenkova & Zorukova 2021) even if they present a standard for the language phonotactic organization; c) *a sentence repetition* (processing and repetition of 20 sentences with increasing length and different grammatical complexity).

Discussion

A precise assessment of speech and language in children with ASD must take into account the complexity of the linguistic system depending on the native language (phonological, lexical, morphological, syntactic processing and skills as well as pragmatic and discourse processing and skills) and should be conducted in comparison cross-linguistic studies. It is mentioned in literature that speech and language characteristics are specific in children with ASD, and they change with the age of children, these changes are partially described (Marini, Magni, Valeri, & Ozbič, 2020; La Valle, Plesa-Skwerer & Tager-Flusberg, 2020), but there is a lack of this analysis in Russian-speaking children. Linguistic assessment in children with ASD should obligatory be conducted with complex neuropsychological assessment.

Being the international and polylingual instruments, VB-MAPP and BVL_RU can provide the detailed description of speech processing and production in children with ASD being supported by the traditional for Russia methods of neuropsychological and speech assessment.

Conclusion

The studies carried out during the creation of a model for complex support of preschool children with ASD prove the need to develop a comprehensive model of neuropsychological assessment and study of speech development for children with ASD of preschool age. The comprehensive model includes a new methodological framework, which implements the achievements of cognitive sciences, neuropsychology and neurolinguistics in interdisciplinary fields. This methodological basis opens up new ways for the study of language and speech in their polyaspect connections with the intellect and with all cognitive processes, which in relation to research in the field of ASD is both new and promising. The results of the presented study can be implemented into the programs of teaching preschool children with ASD, and can also become the basis for the further development of such comprehensive model for schoolchildren with ASD, for the formation of individual habilitation programs and trajectories of medical support.

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