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Evaluation of Motor and Oral-motor Imitation in the Context of Pragmatic Communication Assessment in Children with Autism Spectrum Disorder, Mild Intellectual Disability, Specific Language Impairment and Typical Population

Abstract: Imitation is one of the major components in the development of pragmatic communication behaviour in all individuals. The ability to imitate and its possible impairment might play a significant role in diagnosing pragmatic language disorders in children of various groups with a risk of physiological speech development disorders stemming from their primary health disability, including people with autism spectrum disorders. In the process of designing and verifying a new assessment material for the evaluation of the ability to recognize pragmatic language disorders in people with autism spectrum disorders, the authors used selected items to assess the capability of motor and oral-motor imitation in children with autism spectrum disorders, specific language impairment (developmental dysphasia), mild intellectual disability, and typically developing children. The paper describes partial results of this research and discusses their potential correlations with the assessment of the pragmatic level of language in children with autism spectrum disorders from the perspective of the speech-language therapist.

Key words: Communication pragmatics, options of pragmatic communication level, pragmatically oriented communication situations, children with autism spectrum disorder

Introduction

Imitation of motor behaviour is one of the major components in the development of pragmatic communication behaviour in all individuals. According to a study by G. Mendoza and H. Merchant,[1] the biological nature of this fact can be explained by the evolutionary pressure of the growing complexity of motor behaviour in primates on the development of specific phylogenetically younger cognitive abilities in primates, such as the ability to produce and per-

[1] G. Mendoza, H. Merchant: *Motor system evolution and the emergence of high cognitive functions*. "Progress in Neurobiology" 2014, vol. 122, pp. 73–93. Available from: 10.1016/j.pneurobio.2014.09.001 [access: 1.11.2017].

ceive speech or to distinguish and imitate another individual, or to reproduce rhythmic musical structure.[2] Moreover, these processes are largely genetically conditioned, as suggested for example by S. Fisher, S. Graham, and P. Deriziotis[3] and are associated with neuroanatomical structural deviations in the region of frontotemporal and frontoparietal connections, which was also demonstrated in children with autism spectrum disorders (ASD). In these children, the abovementioned regions are deficient, which may be the cause of the children's motor difficulties and functional disintegration of perception of behaviours associated with emotional and social interaction-based abstract emotional concepts.[4]

According to several authors, the ability to imitate – and its possible impairment – plays a significant role in diagnosing pragmatic language disorders in children of various groups with a risk of physiological speech development disorders stemming from their primary health disability.[5] At the same time, an abnormal or atypical pragmatic level of language is one of the major diagnostic categories monitored in the assessment of autism spectrum disorders, although the latest research by M. Wiklund[6] should be considered here. Its conclusions, based on a conversation analysis, suggest that in people with autism spectrum disorders, a much higher interference concerning the understanding of the pragmatic meaning of speech causes an excessively literal perception of a language-based communication situation and a loss of context of the main topic rather than impaired recognition of prosodic features in speech or non-verbal communication aspects.

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[2] R. Ptak, A. Schnider, J. Fellrath: *Opinion: The Dorsal Frontoparietal Network: A Core System for Emulated Action*. "Trends in Cognitive Sciences" 2017, vol. 21 (1), pp. 589–599.

[3] S. Fisher, S. Graham, P. Deriziotis: *Insights into the Genetic Foundations of Human Communication*. "Neuropsychology Review" 2015, vol. 25 (1), p. 3. Available from: 10.1007/s11065-014-9277-2 [access: 21.08.2017].

[4] R.L. Moseley, F. Pulvermüller: *Special issue: Review: What can autism teach us about the role of sensorimotor systems in higher cognition? New clues from studies on language, action semantics, and abstract emotional concept processing.* "Cortex" 2017. Available from: 10.1016/j.cortex.2017.11.019 [access: 12.12.2017].

[5] K. Vitásková, L. Šebková: *The Variable Professional Perception in Assessment of Pragmatic Language Level in Autism Spectrum Disorders and Related Developmental Difficulties*. "Procedia – Social and Behavioral Sciences" 2016, vol. 237, pp. 1019–1025.

[6] M. Wiklund: *Interactional challenges in conversations with autistic preadolescents: The role of prosody and non-verbal communication in other-initiated repairs*. "Journal of Pragmatics" 2016, vol. 94, pp. 76–97.

Assessment of oral-motor and motor imitation in relation to communication pragmatics

The assumptions mentioned above are obvious for example in people with autism spectrum disorders, as suggested by J.L. Stevenson, C.E. Lindley and N. Murlo.[7] Their findings show that motor skills were a much stronger predictor of a later diagnosed autism spectrum disorder than the assessment of the then state of pragmatic skills. Children with a later ASD diagnosis showed less motor behaviour compared with children with the so-called neurotypical development without impaired speech development. Children aged three to eighteen were monitored in a longitudinal manner. However, the impairment mechanism of imitation behaviour in people with autism spectrum disorders is subject to a broad debate. Despite some critical controversy concerning the complexity and ambiguity of the hypotheses associated with the clarification of the nature of motor imitation in people with ASD, the study primarily highlights the weak preference of perception or attention concerning the so-called biological movement or the weak ability to assess the intention to action. This results in, inter alia, impaired transformation of the visually perceived perspective into motor imitation.[8] At the same time, the relationship between (visual) perceptual processes and motor processes consists of various sub-representational phenomena aimed at various functions, which – according to G. Ferretti[9] – could explain the nature of motor representations.

The monitoring and assessment of subtle and often hidden markers of impairment or deviations from the neurotypical development of communication behaviour plays a key role in early and, if possible, differential diagnosis of disrupted communication ability, which is in addition to the primary speech and language development disorders without clear symptoms of atypical non-verbal communication associated with autism spectrum disorders, sensorineural hearing impairment and other aetiological predeterminants, as suggested for example by A. O'Hare[10]

[7] J.L. Stevenson, C.E. Lindley, N. Murlo: *Retrospectively Assessed Early Motor and Current Pragmatic Language Skills in Autistic and Neurotypical Children*. "Perceptual & Motor Skills" 2017, vol. 124 (4), pp. 777–794.

[8] M. Vanvuchelen et al.: *Review article: Understanding the mechanisms behind deficits in imitation: Do individuals with autism know 'what' to imitate and do they know 'how' to imitate?* "Research in Developmental Disabilities" 2013, vol. 34, pp. 538–545. Available from: 10.1016/j.ridd.2012.09.016 [access: 12.12.2017].

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or K.K. Poon, L.R. Watson, G.T. Baranek, and M.D. Poe.[11] This could result in serious impairment of the child's personality development and a negative impact on the prognosis of the child's adaptability and social interactions, school failure and other undesirable consequences in the future. An important role in the identification of an increased risk of diagnosing autism spectrum disorders as well as specific language impairment is played by the assessment of motor development, although the exact mechanisms of a subtle criterion-based differentiation between the two aetiologically and symptomatically related diagnostic categories are yet unknown (cf., e.g., M. McPhillips, J. Finlay, S. Bejerot, M. Hanley[12]).

As far as their executive nature is concerned, oral-motor imitation skills may be both verbal and non-verbal. For a long time, clinicians in the field of international speech-language pathology have analysed the effect of two forms of oral-motor behaviour on the development of speech and language skills. Frequently, a correlation is made with the monitoring of myofunctional parameters of the development of orofacial system and its primary functions (sucking chewing, swallowing, etc.) (cf., e.g., A. de M. Melo, T.G. dos S. Martins, T.L. dos Silva Santos, A. dos S. Silva, and N.N. da S. Santos,[13] S. Sampallo-Pedroza, L.F. Cardona-Lopez, and K.E. Ramirez-Gomez[14]). In relation to the groups monitored in the present research, what is worth mentioning are the recent results by J.C. Dalton, E.R. Crais and S.L. Velleman,[15] who analysed the relationship between joint attention and the quality of oral-motor imitation in preschool children and observed a decreased ability to produce joint attention in children with autism spectrum disorders, which correlated with a lower quality of non-verbal oral imitation and verbal motor imitation compared with groups of children with a developmental articulation disorder (developmental dyslalia) and a group of typically developing

[11] K.K. Poon et al.: *To what extent do joint attention, imitation, and object play behaviors in infancy predict later communication and intellectual functioning in ASD*? "Journal of Autism and Developmental Disorders" 2012, vol. 42 (6), pp. 1064–1074.

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[13] A. de Medeiros Melo et al.: *Feeding profile and oral motor development of low birth weight infants*. "CEFAC" 2016, vol. 18 (1), pp. 86–94. Available from: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1516-18462016000100086&lng=en&nrm=iso>. http://dx.doi.org/10.1590/1982-021620161814415 [access: 12.12.2017].

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[15] J.C. Dalton, E.R. Crais, S.L. Velleman: *Joint attention and oromotor abilities in young children with and without autism spectrum disorder*. "Journal of Communication Disorders" 2017, vol. 69, pp. 27–43. Available from: 10.1016/j.jcomdis.2017.06.002 [access: 12.12.2017].

children. Moreover, children representing the typical population were capable of better imitation compared with children with the articulation disorder, which is consistent with a similar conclusion concerning the relationship between oral-motor abilities and speech development. Based on these findings, the authors of the study predict a strong positive association between joint attention abilities and the ability to produce serial non-verbal oral-motor and verbal-motor activities in children with ASD. At the same time, a multisensory input combining the auditory, visual and tactile modalities has a positive effect on an increased non-verbal oral as well as verbal imitation performance in all groups of children. According to S. Krishnan, K.J. Alcock, E. Mercure, R. Leech, E. Barker, A. Karmiloff-Smith, and F. Dick,[16] non-language oral-motor skills are positively correlated with the ability to repeat pseudowords, which is treated as one of the significant predictors of successful development of language skills, with reference to an improvement in the ability to perform complex sensorimotor transformations.

In children with mild intellectual disability, monitoring these parameters grows complicated by the excessively variable aetiology involving a wide range of both endogenous and exogenous factors[17] and frequently combining the symptoms into syndromic complexes, sometimes with hardly identifiable progressing prevalence of various subcomponents. These involve motor symptomatology, including orofacial muscle disorders and consequent impairment of the ability of imitation of mimic expressions or general difficulties with imitation of motor behaviour (see, e.g., K. Vitásková, L. Kytnarová[18]).

Children with specific language impairment show milder expressions of imitation difficulties, specifically relating to – for example – sequential gesture diagrams, compared with children with autism spectrum disorders, as suggested by a comparative study conducted by C.R.F. de Souza, L.C. Mazzega, A.C. Armonia, F.C. de A. Pinto, M. Bevilacqua, R. Cristina D. Nascimbeni, A.C. Tamanaha, and J. Perissinoto.[19]

In the process of designing and verifying the new assessment material for evaluating the ability to discern pragmatic language disorders in people with autism spectrum disorders, the authors used selected items to assess the ability

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[16] S. Krishnan et al.: *Articulating Novel Words: Children's Oromotor Skills Predict Nonword Repetition Abilities*. "Journal of Speech, Language & Hearing Research" 2013, vol. 56 (6), pp. 1800–1812. Available from: 10.1044/1092-4388(2013/12-0206) [access: 12.12.2017].

[17] A. Reichenberg et al.: *Discontinuity in the genetic and environmental causes of the intellectual disability spectrum*. "Proceedings of the National Academy of Sciences" 2017, vol. 114 (40), pp. 1098–1103.

[18] K. Vitásková, L. Kytnarová. *Pragmatická jazyková rovina u osob s poruchami autistického spektra*. Olomouc, Univerzita Palackého 2017.

[19] A.C.R.F. de Souza et al.: *Comparative study of the imitation ability in Specific Language Impairment and Autism Spectrum Impairment*. "CoDAS" 2015, vol. 27 (2), pp. 142–147. Available from: https://dx.doi.org/10.1590/2317-1782/20152014194 [access: 12.12.2017].

of motor and oral-motor imitation in children with autism spectrum disorders, specific language impairment (developmental dysphasia), mild intellectual disability, and children from the typical population group.

Description of the study – objectives, methodology, and results

As part of a GACR research project, i.e. GA 14-31457S (2014–2016) titled "Pragmatic language level in people with autism spectrum disorders" (the chief researcher: Assoc. Prof. Kateřina Vitásková), the authors used the original assessment material for evaluating the pragmatic level of language in children with autism spectrum disorders from the perspective of the speech-language therapist, which served as the main research tool for juxtaposing the performance of the four selected groups of children aged between 4 and 15. Specifically, these were children with autism spectrum disorders, mild intellectual disability, specific language impairment (developmental dysphasia), and typically developing children (nevertheless, children with mild motor articulation deficit – developmental apraxia of speech – DAS were not excluded). Each group consisted of 30 children, so the authors assessed a total of 120 children, 81 boys and 39 girls. The main part of the assessment material focused on a comparison of children's test performance using visual graphical diagrams, observing the level of relevant pragmatic communication behaviour. For the purposes of this paper, these parts have been selected that focus on a comparison between motor imitation with and without an object and oral-motor imitation, which was part of a broader assessment approach (see, e.g., K. Vitásková, L. Kytnarová).[20]

As shown in Figure 1, the imitated oral-motor movements included tongue protrusion, lip protrusion, showing teeth, mandibula (jaw) depression. Moreover, children used gestures to imitate motor activity with an object (drinking from a cup, combing one's hair, kissing a toy, feeding an animal) and without an object (clapping, waving, hiding one's eyes, stamping one's feet).

Although the average age of the children in the sample was somewhat lower than in other groups of children, the best result was achieved by children from the typical population group, who made mistakes only in two oral-motor items (specifically 20% of children in lip protrusion and 10% of children in tongue protrusion). No mistakes were made in other types of imitation behaviour.

[20] K. Vitásková, L. Kytnarová: *The Role of Speech and Language Therapist in Autism Spectrum Disorders Intervention – An Inclusive Approach*. "Advances in Speech-language Pathology" Rijeka, InTech 2017. pp. 355–370. Available from: https://www.intechopen.com/books/advances-in-speech-language-pathology/the-role-of-speech-and-language-therapist-in-autism-spectrum-disorders-intervention-an-inclusive-app [access: 12.12.2017].

Lip protrusion was generally the worst imitated motor activity across the monitored groups; the worst performance was observed in children with specific language impairment – developmental dysphasia (47% of children), who performed even worse than children with mild intellectual disability (error rate of 40%). A very surprising finding was the performance of children with autism spectrum disorders, who achieved slightly worse results in this item compared with children from the typical population (23% – in fact there was just one more child with incorrect performance). In this item, children with ASD made half the number of mistakes compared with children with mild intellectual disability or developmental dysphasia. However, in children with autism spectrum disorders the authors of the present paper observed mistakes in the whole spectrum of oral-motor imitation and also motor imitation, both with an object and without an object. In this group, motor imitation behaviour was the worst of all groups of children, but the group constituted only about 10 % of children, which is not a considerably high proportion regarding the diagnostic criteria and the description of the difficulties with imitation referred to in specialized resources. The children with mild intellectual disability made mistakes only in imitation with an object (2 children); in this group, no mistakes were made in imitation without an object. Both motor imitation items were performed correctly by the children with developmental dysphasia. Apart from lip protrusion, the largest number of mistakes was made in 'showing teeth' by the children with mild intellectual disability (20%) and autism spectrum disorders (17% of children). Almost no mistakes were made in mandible depression, which evokes mouth opening (e.g. yawning or eating – 'yum'). A mistake was made only by 2 children with ASD and 1 child with developmental dysphasia.

A qualitative analysis of the results of selected children suggests considerable age variability among children with both successful and unsuccessful performance. The child who had the worst result was a boy with Asperger syndrome (KAS17), who was 8 years and 4 months old at the time of testing and apart from correct mandible depression, was unable to imitate any of the oral-motor movements and was incapable of general motor imitation with an object and without an object. On the other hand, a much younger boy with a more serious diagnosis of child autism, aged 4 years and 6 months (KAS16), was capable of performing all the imitation activities at the time of testing.

Discussion

The aforementioned findings could be explained by stating, for example, that imitation is an older ability in terms of evolution and is gradually becoming inhibited as the personality of the child develops and gives way to cognitive judgement and self-control (see, e.g., S.S. Jones[21]). Therefore, as a result of a preference for his cognitively conditioned judgement, a boy with Asperger syndrome could have considered the required imitation tasks inappropriate, insignificant, insufficiently justified regarding the situation, which, however, would have been paradoxically in favour of functional pragmatics of the boy's behaviour; in the required task the boy could have simply lacked a "sense of relevance." This assumption is also confirmed by the boy's flawless performance in a subtest aimed at distinguishing visual diagrams; the situations shown relate directly to usual social-communication and interaction situations, which the boy assessed in an adequate way. On the contrary, the boy's relatively high proportion of incorrect responses in the "visual contact" item assessed by means of a behaviour observation scale could explain the difficulties with motor imitation requiring targeted visual perception and the use of both gnosis and oral-motor as well as motor praxis (see, e.g., K. Vitásková, M. Málková, A. Hlavinková[22]). On the other hand, a boy diagnosed with more severe ASD showed simpler imitation behaviour, which resulted in flawless imitation performance; however, he made mistakes in distinguishing visual diagrams in the "want something" and "proxemics" items (which was generally one of the most difficult communication situations among all groups of children), waiting for communication and changing communication roles. Identical results in assessing visual diagrams were achieved by two girls with child autism of different age (KAS14 – 12 years and 11 months, KAS15 – 4 years and 3 months), who made the same mistakes in lip protrusion and mandible depression; girl KAS15 also in both tests of motor imitation, girl KAS14 succeeded in imitation with an object. However, she experienced more difficulties in "problem behaviour" (especially observed behaviour), in "eye contact" or "sensory interaction." She suffered from disrupted social interaction and social abilities.

As far as the error rate in motor imitation without an object in children with mild intellectual disability is concerned, the cause could be the frequent coin-

[21] S.S. Jones: '*The Development of Imitation in Infancy*', *Philosophical Transactions*. "Biological Science" 2009, no. 1528, p. 2325. Available from: 10.1098/rstb.2009.0045 [access: 12.12.2017].

[22] K. Vitásková, M. Málková, A. Hlavinková: *Ověřování výzkumných možností diagnostiky orální stereognozie v oblasti symptomatických poruch řeči u dětí – význam pro interdisciplinární praxi*. "PhD existence. Česko-slovenská psychologická konference (nejen) pro doktorandy a o doktorandech. Sborník odborných příspěvků". Olomouc, Univerzita Palackého v Olomouci 2016, pp. 124–131.

cidence with delayed development or deficits in motor development, including manual dexterity and balance skills, which tend to be aetiologically conditioned. At the same time, the quality of motor activity correlates with cognitive performance, as confirmed for example by P.J. Vuijk, E. Hartman, E. Scherder, and C. Visscher.[23] Children with developmental dysphasia are symptomatologically affected to a relatively larger extent in the sense of coordination activities and especially motor dynamic praxis, as confirmed in their generational study aimed at familial effects in the context of specific language impairment by M. Serra and R. Lluent[24] – this is consistent with the results of the present study. However, more common disorders include oral-motor deficits of a non-verbal nature and disrupted speech fluency combined with impaired phonematic auditory perception. A finding that supports a positive prognosis in this group of children is that adults with specific language impairment later show lexically and syntactically inhibited and frequently simplified speech, which is thought to be on an acceptable pragmatic level and applicable in everyday life.

From a speech-language therapy perspective, the worst result in the area of lip protrusion is associated with a disrupted or limited ability to produce movement of the *musculus orbicularis oris*, which is a major mimic muscle in the orofacial region. The weakening of the ability to imitate the movements of this muscle might prevent not only for example lip puckering in conjunction with an emotional expression (e.g. thinking or "sending a kiss") but also primary activities related to biting off, chewing, and other essential movements, including the production of the bilabial closure necessary for keeping saliva in the mouth, or the production of an adequate rest position of the tongue. Lip movements during the imitation or production of a mimic expression might be significantly affected by verbal instructions, as confirmed for example by K.L. Schmidt, J.M. VanSwearingen, and R.M. Levenstein,[25] but also Vitásková, Tabachová.[26]

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[23] P. J. Vuijk et al.: *Motor performance of children with mild intellectual disability and borderline intellectual functioning.* "Journal of Intellectual Disability Research: JIDR" 2010, vol. 54 (11), pp. 955–965. Available from: 10.1111/j.1365-2788.2010.01318.x [access: 6.03.2017].

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[25] K.L. Schmidt, J.M. Van Swearingen, R.M. Levenstein: *Speed, Amplitude, and Asymmetry of Lip Movement in Voluntary Puckering and Blowing Expressions: Implications for Facial Assessment*. "Motor Control" 2015, Vol. 9, no. 3, p. 270.

[26] K. Vitásková, J. Tabachová: *The importance of evaluation of orofacial movements in children with and without speech, language, and communication needs*. "EDULEARN2016 Proceedings" 2016, pp. 3402–3411.

Conclusion

The part of the study discussed above suggested a surprising conclusion: relatively unimpaired performance in all groups of children (with ASD, mild intellectual disability, specific language impairment, namely developmental dysphasia, and from the typical population) in items focused on the assessment of oral-motor imitation and motor imitation with an object and without an object. The worst results in oral-motor imitation were achieved by children with mild intellectual disability. The most impaired performance in all groups of children was observed in lip protrusion, but a surprising finding was that children with autism spectrum disorders made mistakes in multiple items of oral-motor imitation and unlike other groups also in motor imitation both with an object and without an object. Therefore, the impairment of their imitation behaviour is more generalized, while in children with developmental dysphasia their imitation is impaired primarily in the oral-motor area. However, the results are to a large extent individually variable in terms of the children's age, gender, and the severity of their diagnoses, and in some cases, they correspond with impaired visual contact and other parameters of pragmatic communication behaviour. However, everything should be subjected to further investigation.

The authors of the present study demonstrate that the above mentioned approach to the assessment of motor behaviour in the context of evaluating the ability to perceive the pragmatic meaning of communication can contribute to a more precise diagnosis not only in the monitored groups but also generally in the assessment of the pragmatic level of language in children with other developmental specifics from the perspective of speech-language therapy.

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