MULTIAGENT MODEL OF PERCEPTUAL SPACE FORMATION IN THE PROCESS OF MASTERING LINGUISTIC COMPETENCE

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The model of the early development of language competencies proposed in this paper, takes into account the social factors effects. It is a simulation model of phonemic imprinting. The model describes the process of perceiving audio stimuli as their mapping into classes of elementary language units. The machine learning algorithm was developed using the results of the study of speech addressed to children. Our model will allow to explore the features of phonetic perception, the cognitive mechanisms that underlie language development, highlight the main factors affecting the duration of the plasticity period. The proposed model gives possibilities to build perceptual maps, design diagnostic tools to describe and study the sensitive period. The model can also be used to create speech systems that are resistant to various influences and effective when used in conditions of high noise.

Keywords: *multiagent systems, artificial intelligence, artificial neuron nertworks, speech recognition, plasticity period, motherese.*

REFERENCES

1. Jurafsky D., Martin J. Speech and Language Processing: An introduction to natural language processing, computational linguistics, and speech recognition. Boston, Prentice Hall, 2008. P. 1032.
2. Waibel A., Lee K.-F. Readings in Speech Recognition. Berlington, Morgan Kaufman, 1990. P. 680.
3. Stolcke Andreas & Droppo Jasha. Comparing Human and Machine Errors in Conversational Speech Transcription. 137-141. 10.21437/Interspeech. 2017-1544.
4. Saon George & Kurata Gakuto & Sercu Tom & Audhkhasi Kartik & Thomas Samuel & Dimitriadis Dimitrios & Cui Xiaodong & Ramabhadran Bhuvana & Picheny Michael & Lim Lynn-Li & Roomi Bergul & Hall Phil. English Conversational Telephone Speech Recognition by Humans and Machines. 132-136. 10.21437/Interspeech.2017-405.
5. Strange W. Speech Perception and Linguistic Experience: Issues in Cross-Language Research. Baltimore, York Press, Baltimore, 1995. P. 492.
6. Tseitlin S.N. *Yazyk i rebenok: Lingvistika detskoy rechi* [A Child and a Language: Child Speech Linguistics]. Humanitarian Publishing Center VLADOS. Moscow, 2000.
7. Chomsky N.A. A Review of Skinner's Verbal Behavior. In: Jakobovits, L.A., Miron, M.S. (eds.) Readings in the Psychology of Language. Boston, Prentice-Hall, 1967. P. 636.
8. Morozov V.P., Vartanyan I.A., Galunov V.I. *Vospriyatiye rechi: voprosy funktsional'noy asimmetrii mozga* [Speech Perception: Problems of Functional Brain Asymmetry] Science, St. Petersburgh, 1988.
9. Newell A. Unified Theories of Cognition. Cambridge, Massachusetts: Harvard University Press, 1990. P. 576.
10. Haikonen P. The Cognitive Approach to Conscious Machines, Exeter, UK, imprint Academic, 2003. P. 300.
11. Schunk D.H. Learning Theories: An Educational Perspective, Boston, Pearson Merrill Prentice Hall, 2011. P. 576.

12. Pinker S. The Language Instinct: How the Mind Creates Language. New-York, Harper Perennial, 2007. P. 494.
13. Kotseruba Iu, Tsotsos J.K. A Review of 40 Years of Cognitive Architecture Research: Core Cognitive Abilities and Practical Applications. arxiv.org/abs/1610.08602
14. Wooldridge M. An Introduction to Multi-Agent Systems. Hoboken, New-Jersey, Wiley, 2009. P. 366.
15. Nagoev Z.V. *Intellektika, ili Myshleniye v zhyvych i iskusstvennych sistemach* [Intellectics, or thinking in living and artificial systems]. Publishing House KBSC RAS. Nalchik, 2013.
16. De Mulder W., Bethard S., Moens M.-F. A Survey on the Application of Recurrent Neural Networks to Statistical Language Modeling. Computer Speech and Language, 2015. № 30(1). P. 61-98.
17. Deng L., Li X. Machine Learning Paradigms for Speech Recognition: An Overview. IEEE Transactions on Audio, Speech, and Language Processing. 2013. №21(5). Pp. 1060-1089.
18. Nagoev Z., Lyutikova L., Gurtueva I. Model for Automatic Speech Recognition Using Multi-Agent Recursive Cognitive Architecture, Annual International Conference on Biologically Inspired Cognitive Architectures BICA, Prague, Czech Republic http://doi.org/10.1016/ j.procs.2018.11.089
19. Nagoev Z., Gurtueva I., Malyshev D., Sundukov Z. Multi-agent Algorithm Imitating Formation of Phonemic Awareness. In: Samsonovich A. (eds) Biologically Inspired Cognitive Architectures 2019. BICA 2019. Advances in Intelligent Systems and Computing. Vol. 948. Springer, Cham https://doi.org/10.1007/978-3-030-25719-4_47
20. Nagoev Z.V., Gurtueva I.A. *Bazovye element kognitivnoi modeli mehanizma vospriyatiya rechi na osnove multiagentnogo rekursivnogo intellekta* [Fundamental Elements for Cognitive Model of Speech Perception Mechanism Based on Multiagent Recursive Intellect] // News of Kabardino-Balkarian Scientific Center of RAS, 2019. № 3(89). Pp. 3-14.
21. Garnica O. Some prosodic and paralinguistic features of speech to young children. In: Snow, C., Ferguson, Ch. (eds.): Talking to Children. Cambridge, Cambridge University Press, 1977. P. 63.
22. Fernald A. Four-month-old infants prefer to listen to motherese. Infant Behavior and Development, 1985. №8. Pp.181-95.
23. Fernald A., Kuhl P. Acoustic determinants of infant preference for Motherese Speech. Infant Behavior and Development, 1987. №10. Pp. 279-93.
24. Moerk E.L. Principles of interaction in language learning. Merril-Palmer Quaterly, 1972. № 18. Pp. 229-257.
25. Pye C. Quiché Mayan speech to children // Journal of Child Language. 1986. № 13(1). Pp. 85-100.
26. Vygotsky L.S. *Myshlenie I Rech'* [Thinking and Speech]. St-Petersburg: Piter, 2019.
27. Conboy B.T., Kuhl P.K. Impact of second-language experience in infancy: Brain measures of first- and second-language speech perception. Developmental Science, 2011. № 14. Pp. 242-248. https://doi.org/10.1111/j.1467-7687.2010.00973.x
28. Doupe A.J., Kuhl P.K. Birdsong and human speech: Common themes and mechanisms. In: Zeigler, H.P., Marler, P. (eds.): Neuroscience of birdsong. Cambridge University Press, 2008. Pp. 5-31.
29. De Cheveigne A., Kawahara H. YIN, a fundamental frequency estimator for speech and music // The Journal of the Acoustical Society of America, 2002. № 111(4). Pp. 1917-1930.
30. Maher R.C., Beauchamp J.W. Fundamental frequency estimation of musical signals using a two-way mismatch procedure // The Journal of the Acoustical Society of America. 1994. № 95, 2254 https://doi.org/10.1121/1.408685
31. Coates A., Ng A.Y. Learning Feature Representations with K-Means. In: Montavon G., Orr G.B., Müller KR. (eds) Neural Networks: Tricks of the Trade. Lecture Notes in Computer Science, 2012. Vol. 7700. Springer, Berlin, Heidelberg.
32. Zinder L.R. *Obshaya Fonetika* [The General Phonetics]. The Higher School, Moscow, 1979.

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