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ARE NEURAL SUBSTRATES OF LANGUAGE AND COMMUNICATION DISTINCT?

Universal Grammar serves as a basis for acquiring language competence, but it is not sufficient to acquire communicative competence. To be a competent sender or receiver of an utterance, one needs to be able to infer another person's intentions or beliefs. In other words, one needs to have a theory of mind. Are then neural substrates of linguistic and communicative abilities distinct, too? The paper characterizes language as a specific human feature and briefly describes both language competence and communicative competence. Finally, it presents the results of an fMRI study according to which communicative and linguistic abilities rely on cerebrally (and computationally) distinct mechanisms.

Key words: language, communication, Universal Grammar, theory of mind, neuroimaging

Introduction

"The goal of cognitive psychology is to develop and test theories about how the mind works" (Mather, Cacioppo, Kanwisher, 2013, p. 108). Neuroimaging studies, especially those based on functional magnetic resonance imaging (fMRI), have revolutionized our knowledge on this issue. Since the first report of an aphasic patient by Pierre Paul Broca, the localization of language function in the brain has been disputed for 150 years. Until recently, the Wernicke-Lichtheim-Geschwind model constituted a general functional-anatomical framework for language processing (cf. Poeppel, Hickok, 2004). Functional neuroimaging research has brought radical changes to this classical approach.

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Currently, it is believed that language is not represented as distinguished parts of one cortical area in the left hemisphere. Instead, linguistic functions are carried out based on groups of related and interacting networks of brain structures, which partially overlap but are specialized to some extent. These opinions seem to contradict the modular model of mind, while language has been consistently taken as a classic example of mind module. So far, the research has not yielded any definite solution to this contradiction. Recently, Fedorenko, Behr and Kanwisher (2010) presented a study that used fMRI to define classic language regions functionally in each subject individually and then examine the response of these regions to the nonlinguistic functions most commonly argued to engage these regions: arithmetic, working memory, cognitive control, and music. Little or no response in language regions to these nonlinguistic functions was found. These data support a clear distinction between language and other cognitive processes. The question whether cognitive operations are modular or distributed across domains remains open. Functional MRI research, however, is able to bring us closer to the answer.

Functional MRI studies are able to improve our understanding of relations between language and communication. In natural communication, the ability to infer someone's intention from an utterance seems more crucial than decoding the utterance's literal meaning. To be a competent sender or receiver of an utterance, one needs to be able to infer another person's intentions or beliefs. In other words, one needs to have a theory of mind.

Are then language and communication supported by overlapping or distinct parts of the human brain? First, we will characterize language as a specific human feature. Next, we will briefly describe both language competence and communicative competence. Finally, we will present the results of the fMRI study that answers the question posted above.

Language as a specific human feature

In the introduction to *Language and Human Behavior*, well-known linguist Derek Bickerton (1995) considers reasons for which behavioral sciences have not reached their main objectives so far. While doing that, he points to one human capacity that underlies most or probably all other characteristics that distinguish humans even from their closest relatives among the apes. He claims that the current, unsatisfactory state of behavioral sciences results from one wrong assumption: we treat and examine the characteristics of *Homo sapiens* as if they were separate, unrelated traits and we fail to notice that they all stem from a single capacity. And he believes that language is this central capacity.

What is so specific about human communication that distinguishes it from all the communication systems of other animal species? Michael Tomasello (2003) notes two main differences. First, it has a symbolic character. Thanks to linguistic

symbols – which are conventional, i.e. they result from social agreement – it is possible to share one's attention with another person by directing his or her attention (or mental state) towards various external objects. Communication of other species is different, probably due to the fact that members of other species do not attribute any mental states to each other that could be shared or directed. Communication of animals relates to behavior or motivational states, while human communication relates to mental states. This mental aspect of human communication gives a unique power of communication to linguistic symbols and allows them to be used in order to relate to and state about various objects, events or situations. A second distinctive feature of human language is its grammatical convention that stems from historical and ontogenetic processes. "Each of the different languages of the world, both spoken and signed, has its own syntactic and other grammatical conventions for structuring utterances so as to solve the various problems raised by informative communication. Indeed, each of the different languages of the world has a variety of prepackaged constructions that combine various types of signs/words and grammatical markers for use in recurrent communicative situations; for example the English passive construction (e.g. "The dog was injured by the car", in which the subject is the patient of the action) is composed of a certain arrangement of certain constituents (each of which is its own constructional pattern as well) for a specific communicative function" (Tomasello, 2008, p. 275). Such linguistic constructs are linguistic signs in their own right and they carry meanings. Consequently, words (relatively simple linguistic forms) and grammar constructions (relatively large linguistic forms) make two ends of the same semiotic continuum.

Natural language is the only system that can be characterized at two levels or in two categories. At the first level there are phonemes: sounds that do not carry any meaning but they can be aggregated by phonological rules into the smallest meaningful units: words (or, to be more precise, into morphemes – as a word can consist of several morphemes). This level can be considered as a vocabulary that belongs to a given language. Naturally, even at this first level, communication is possible. A code that consists of signs but lacks rules of their aggregation is called a protolanguage.

Only at the second level, based on syntactic rules, is it possible to merge the elements of the first level into sentences. The number of phonemes in any language is fixed, but the number of sentences that can be built using them is theoretically unlimited. Moreover, thanks to the mechanism of recursion, that is by nesting one element of a sentence into another element of the same type, it is possible to build sentences of unlimited length. Let us refer to an example from Keith Devlin (1999, p. 155-156) here. Imagine a native English speaker with an active vocabulary of 10,000 words. How many sentences with maximum 20 words can he build? Statistical analysis of language shows that if our speaker creates a sentence and is stopped at a randomly chosen moment, there are on average

about 10 words that can be used to continue this sentence in a grammatically correct manner. This means that the number of grammatically correct English sentences that consist of up to 20 words is 10^{23}.

Another feature of human verbal communication is dislocation in time and space. It is possible to use language to relate to events that are unrestrictedly distant in time and space, or even to fictional events. Finally, language code is culturally transmitted: it is passed on in the process of socialization that is unique to the *Homo sapiens* species.

It appears obvious that we use language to communicate. However, as Kurcz (2005, p. 11) points out, "the scope of the concepts of 'language' and 'communication' overlaps only partially, namely when we speak about linguistic or verbal communication, about communicating by means of natural language." Indeed, communication can have nonverbal forms. Moreover, communication is a capacity of other animal species as well and they communicate within and between species. Consequently it is possible to identify features that are specific exclusively to human language communication. Communication cannot be perceived as a wider concept that contains natural language. Language is used not only for communication, it also has a symbolic function: it can be used to represent reality in the human mind. These two basic functions of language are associated with two competences: language competence and communicative (pragmatic) competence.

Language competence and communicative competence

The concept of language competence has been used in the field of psycholinguistics almost since the very beginning of this science. Psycholinguistics – an interdisciplinary field of research dedicated to exploring the nature of how people use their language – was born in 1951. That year, at a symposium at Cornell University (USA) attended by psychologists, linguists, philosophers and cultural anthropologists, the term 'psycholinguistics' was introduced to describe a new branch of science. In 1957, Noam Chomsky's *Syntactic Structures* was published and Chomsky was soon hailed as the father of modern linguistics. Indeed, the history of linguistics can be divided into two distinct periods: B.C. and A.D., where the former stands for *Before Chomsky* and the latter for *After the Dissertation* (Devlin, 1999, p. 133-134). Based on his dissertation, Chomsky's *Syntactic Structures* was "the snowball which began the avalanche of the modern 'cognitive revolution'" – as stated in the introduction (by David W. Lightfoot) to the second edition of this book (Chomsky, 2002). The theory of grammar presented there and in subsequent works by Chomsky (1995) has largely contributed to a scientific revolution not only in linguistics but also in psychology, especially in psychology of language and cognitive psychology. This theory is known as the theory of language competence. Besides Chomsky's revolutionary idea that language acquisition is possibly based on universal grammar rules which are embed-

ded in the human mind, we should list innovative works by Jerome S. Bruner, George Miller and Herbert Simon, as well as works in mathematics and logic by Alan Turing and Alonzo Church. The legacy of all of these authors, along with Chomsky's work, enabled the development of cognitive psychology and helped establish its position as an alternative to the behaviorism that had dominated psychology in the first half of the 20th century.

Language competence is, by its nature, tacit knowledge. It is the capacity of every human to understand and to create a theoretically unlimited number of sentences. "If language is a set of sentences and this set is unlimited, this [tacit] knowledge cannot have the form of fixed sentences, because such a set would need to be limited. Instead, it consists of rules that allow sentences to be created. These rules stand for the grammar of any given language, thus, grammar provides a description for human language competence" (Kurcz, 1993, p. 29).

We should distinguish linguistic (or language) competence from linguistic performance, i.e. from particular acts of speech in any given language that are implementations of the competence. The term 'language competence' has been slowly going out of use and is being replaced with the term 'I-language' (internal language – in contrast to external language – E-language) or with the term 'Universal Grammar' (UG). Another term that is being used to describe innate grammar rules, which are universal for all languages, is 'faculty of language'. In their seminal article "The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?", published in *Science* in 2002, Marc Hauser, Noam Chomsky and W. Tecumseh Fitch made a distinction between 'faculty of language in the broad sense' (FLB) and 'faculty of language in the narrow sense' (FLN). The authors argued that "FLN – the computational mechanism of recursion – is recently evolved and unique to our species" (Hauser, Chomsky, Fitch, 2002, p. 1573). Faculty of language in the broad sense also consists of a phonological system based on the operations of the sensory-motor apparatus and a conceptual-intentional system conferring meaning to syntactically structured representations. The authors' considerations on relations between FLB and FLN and on their specifics in the *Homo sapiens* species provoked a discussion in another leading journal, *Cognition* (Pinker, Jackendoff, 2005; Fitch, Hauser, Chomsky, 2005; Jackendoff, Pinker, 2005). In this discussion, Steven Pinker and Ray Jackendoff criticize the too narrow conceptualization of FLN and they remark on many aspects of grammar that are not recursive, e.g. phonological or morphological rules. The discussion on the specifics of linguistic competence remains open (cf. Vicari, Adenzato, 2014).

The shift in researchers' interests towards the communicative (pragmatic) function of language stems from the theory of speech acts that was introduced by British philosopher John L. Austin (1962) and developed by John R. Searle (1965; 1969). This shift involves focusing on and exploring empirical speech acts instead of analyzing an abstract system of natural language. The unit of analysis is not a

sentence and the underlying statement anymore, but an utterance, which consists of a statement that also conveys the speaker's intention, revealed in a speech act.

In the process of communication, the problem lies not only in decoding the literal meaning of an utterance, but also in recognizing what meaning is revealed by the speaker (speaker's meaning). The meaning revealed by the speaker is not encoded, it is implicit, thus its recognition depends on how accurately the listener recognizes the speaker's intentions. This aspect of communication was noticed by Paul H. Grice (1975), who introduced the concept of conversational implicatures. The issue of conversational implicatures has been developed in the concept of presumptive meanings by Stephen Levinson (2000) as well as in works on relevance theory by Dan Sperber and Deirdre Wilson (2002).

The concept of language competence represents the human capacity to use language. This capacity is built on an innate biological predisposition universal for all languages – the so-called Universal Grammar. In parallel to this concept, Dell Hymes (1972) introduced the term "communicative competence" to describe the human capacity to use language efficiently and appropriately for any given social situation and relations between social actors. According to Kurcz (2006), both types of competence are equally important and they cannot be merged into one concept, as they stem from two distinct functions of language.

To prove his thesis that infants are extremely social beings from the very moment of birth, if not before, Tomasello (1999) describes two kinds of behavior. First, infants engage in interactive behavior exchanges of a protoconversational nature. Second, they imitate the facial expressions of their caregiver. Such an imitation skill, which enables a baby to notice that "others are just like myself," is a starting point for social cognition (Meltzoff, 2007; Olineck, Poulin-Dubuis, 2007). The revolutionary breakthrough – as Tomasello calls it (*ibid.*) – in a child's understanding of the social world takes place around the 9th month after birth, when the child starts to develop a skill specific to our species, i.e. sharing a field of attention. The child-person and child-object interactions characteristic of the primary period of intersubjectivity become triadic child-person-object/event interactions (the object/event being the focus of shared attention), which is secondary intersubjectivity (Trevarthen, 1980). A child starts to notice others as performers of intentional actions concerning objects. He or she understands object-driven behavior and notices the attention of the other performer directed towards objects.

However, a child must still understand that other people are not only physical agents of intentional actions on objects but also mental agents, with their own beliefs concerning the reality and acting accordingly, i.e. a child must develop a theory of mind. The development of a child's knowledge of mind functioning is gradual. The turning point in a child's understanding of the social world takes place approximately at 4 years of age, when children start to distinguish beliefs concerning the reality from the reality itself and are able to recognize false

beliefs. This shows that a child is able to understand another person's state of mind. Understanding beliefs and desires is a derivative of the understanding and sharing of intentions (Tomasello, Carpenter, Call, Behne, Moll, 2005).

Theory of mind is a prerequisite for assuming another person's point of view and for understanding the person's intentions, which consequently provides the basis for effective communication. Communication requires linguistic competence or the ability to use language, biologically based on the Universal Grammar including a set of general grammar principles shared by all languages and innate to the human mind. But it also requires communicative (pragmatic) competence or the ability to use language in a way that is both efficient and adjusted to a given social situation and to the nature of relations among the participants of the interaction. The model of linguistic knowledge proposed by Kurcz (2005) includes two separate components of the above competence: theory of mind (ToM), being a biological foundation, and metapragmatic knowledge. Kurcz underscores (*ibid.*) that each competence is directly connected with a specific biological basis and it requires exposure to the social and cultural environment to be fully developed. Are then neural correlates of linguistic and communicative abilities distinct, too?

Relation between linguistic and communicative abilities in the human brain

The development of new research techniques, in particular noninvasive examination of the brain such as functional magnetic resonance imaging (fMRI), has allowed to capture activity in the human brain during language processing. "Few events are as thrilling to scientists as the novel method that enables them to see the previously invisible" (Mather, Cacioppo, Kanwisher, 2013, p. 41). It is therefore not surprising that fMRI has allowed for a constantly growing number of studies that investigate psycholinguistic (semantic, syntactic and phonological) factors in language production/comprehension (see Vigneau et al., 2006; Vigneau et al., 2011 for review) or the neural basis of ToM or "mentalizing" (see Mahy, Moses, Pfeifer, 2014 for review). Nonetheless, research on the relationship between linguistic and communication abilities are rare.

One exception is a study conducted by Willems et al. (2010). In this study, the authors independently manipulated communicative intent and linguistic processing to directly test whether the neurocognitive bases of communicative and linguistic abilities are distinct, and how they relate to mentalizing. They hypothesized that mentalizing is essential for selecting communicative actions and, more specifically, that it is essential for adapting communicative behavior to what an interlocutor knows and believes. If the mentalizing abilities used during communicative behavior are related to the language system, there should be an overlap between the cerebral structures supporting mentalizing and those responsible for linguistic processes. Alternatively, if communicative and linguis-

tic capacities are supported by cognitively distinct mechanisms, then different cerebral structures should be sensitive to communicative intent and linguistic difficulty.

The task of the subjects (the senders) was to describe a "target word" (e.g. "beard") to other persons (receivers, confederates) using a single sentence and avoiding fixed "taboo words" (e.g. "chin," "man," "hair," "shave"). The receivers inferred the target words on the basis of the utterances generated by the senders, who were lying in an MRI scanner. Communicative intent was operationalized as the presence or absence of the need to convey a specific concept to a specific agent. The senders were informed that the receivers do not know what the targeted word is (targeted trials), or that they know it (non-targeted trials). In fact, the targeted word was always known to the receiver as he was a research assistant. Moreover, the linguistic difficulty was experimentally manipulated. The taboo words were semantically closely related to the target word (difficult trials) or there was a large semantic distance between target and taboo words (easy trials). In difficult trials the sender needed to build an utterance by searching distant portions of the semantic space surrounding the target word, while in easy trials the sender could use the semantic space adjacent to the target word.

The results show that targeted trials evoked stronger responses than non-targeted trials in a confined portion of the dorsomedial prefrontal cortex (MPFC). This region is a part of what has been called the "ToM" network which includes the right and left temporoparietal junction (RTPJ/LTPJ), superior temporal sulcus (STS), precuneus (PC) and medial prefrontal cortex (MPFC). Many studies have reported activity in these regions, using verbal and non-verbal stimuli, stimuli depicting true beliefs and false beliefs, stimuli in English and non-English languages, those describing beliefs and preferences and describing affective as opposed to purely epistemic states (Dodell-Feder, Koster-Hale, Bedny, Saxe, R., 2011). MPCF was insensitive to the manipulation of linguistic difficulty. On the contrary, in difficult, as compared to easy trials, the left inferior frontal and left inferior parietal cortex were more strongly activated and they were not affected by the communicative intent manipulation. The left inferior frontal cortex (LIFC) is known to be involved in a wide variety of language production and comprehension tasks. Willems et al. (2010, p. 13) conclude that "the generation of communicative utterances relies on a neurocognitive system that is involved in understanding intentions of others, and that is distinct from the language system."

As the authors emphasize (Willems et al., 2010, p. 12-13), "This is evidence against the notion that communication involves a reflex-like mirroring mechanism rooted in the motor system (Rizzolatti & Craighero, 2004). Rather, our results support the notion that planning an effective communicative act involves the generation of social constructs (what an agent supposes his or her interlocutors know and believe) that guide selection of an appropriate communicative action (Frith & Frith, 2006; Levinson, 2006; Toni, de Lange, Noordzij,

& Hagoort, 2008)." This conclusion is additionally supported by the results of a meta-analysis conducted by Van Overwalle and Baetens (2009). The aim of their analysis was to explore the role of the mirror and mentalizing systems in understanding other people's action goals. The meta-analysis covered more than 180 fMRI studies on human understanding of intentionality as well as about 40 fMRI studies involving potentially related functionalities (behavior execution and orientation). The results clearly showed that (Overwalle, Baetens, 2009, p. 579) "the mirror and mentalizing systems are two distinct systems, each specialized in the processing of observed sensory or verbal information about other persons but based on different inputs. The mirror system is recruited when moving body parts are observed. The mentalizing system is recruited when no such input is available." This means that, in the absence of biological motions, the mirror system is not activated and does not assist the mentalizing system in inferring intentions of others. Naturally, as the authors point out, this does not mean that these two systems are disconnected when social inferencing takes place in everyday, real-life situations. They emphasize that their conclusions are based on research in which tasks were often designed to be as pure as possible (perceived motor behavior with little social content for testing the mirror system as opposed to more abstract descriptions in the absence of any motion for probing the mentalizing system).

Important evidence that the neural bases of ToM and language are largely distinct comes from studies on patients with severe agrammatic aphasia (Apperly, Samson, Carroll, Hussain, Humphreys, 2006; Varley, Siegal, 2000; Varley, Siegal, Want, 2001). Apperly and associates (2006) presented a case of 33-year-old patient PH who had a left hemisphere stroke. The stroke affected the left medial and superior temporal gyri as well as the left inferior and middle frontal gyri. PH was tested on a battery of language and ToM tests. The results showed that regardless of his severe grammatical impairments, PH performed well on non-verbal tests of ToM, including 1st- and 2nd-order false belief tasks. This proves that explicit reasoning about beliefs does not depend on having access to grammatical structure, at least in the case of adults.

Concluding comments

Naturally, even if communicative and language abilities seem cognitively and cerebrally distinct, it does not mean that the two systems do not cooperate with each other, for instance during discourse comprehension. Nonetheless, the neuronal mechanisms that underlie comprehension of the communicative functions of utterances (speech acts) remain largely unknown. Noteworthy, the results of recent fMRI studies show that comprehension of speech acts such as requests or inferring the meaning of an utterance based on the context engage cortical areas that are part of the ToM network (Bašnáková et al., 2013; Egorova, Pulvermüller,

Shtyrov, 2014; van Ackeren, Casasanto, Bekkering, Hagoort, Ruschemeyer, 2012). Some scholars suggest including these areas into the traditionally conceptualized network of brain structures that is assumed to be mainly involved in phonological, syntactic and semantic processing (cf. Ferstl, Neumann, Bogler, von Cramon, 2008; Hagoort, 2013).

It should also be noted that some scholars argue that the development of the ability to infer about other people's mental states is dependent on the development of language. Studies on the ontogenesis of ToM reveal that children's performance in false belief tasks is positively correlated with the level of development of their linguistic abilities (Astington, Baird, 2005; Milligan, Astington, Dack, 2007). It has been emphasized that understanding the meaning of words that refer to mental states (e.g. know/don't know, think, believe, guess) as well as comprehension of the syntax of embedded clauses are both necessary conditions for a child to develop theory of mind (de Villiers, 2002; 2007). Even though studies on children provide many valuable insights into the relation between linguistic processes and ToM, the direction of this relation is still not confirmed and disputed among researchers. One possibility is that language is related to mentalization in the case of both children and adults. Second – that language is crucial for acquiring the ability to create representations of mental states, but the two processes are independent in adult life. The results discussed here seem to support the latter hypothesis.

References

van Ackeren, M. J., Casasanto, D., Bekkering, H., Hagoort, P., & Ruschemeyer, S.A. (2012). Pragmatics in action: Indirect and the cortical motor network. *Journal of Cognitive Neuroscience*, *24* (11), 2237–2247.

Apperly, I.A., Samson, D., Carroll, N., Hussain, S., & Humphreys, G.W. (2006). Intact first and second-order false belief reasoning in a patient with severely impaired grammar. *Social Neuroscience*, *1* (3/4), 334-348.

Astington, J.W. & Baird, J.A. (2005). *Why Language Matters for Theory of Mind*. New York: Oxford University Press.

Austin, L.J. (1962). *How to Do Things with Words*. Oxford: Clarendon Press.

Bašnáková, J., Weber, K., Petersson,K., van Berkum, J., & Hagoort, P. (2013). Beyond the language given: The neural correlates of inferring speaker meaning. *Cerebral Cortex* [epub ahead of print].

Bickerton, D. (1995). *Language and Human Behavior*. London: UCL Press.

Chomsky, N. (1995). *The Minimalist Program*. Cambridge, MA: The MIT Press.

Chomsky, N. (2002). *Syntactic Structures*. Berlin: Mouton de Gruyter.

Devlin, K. (1999). *Żegnaj, Kartezjuszu. Rozstanie z logiką w poszukiwaniu nowej kosmologii umysłu* [*Goodbye, Descartes. The End of Logic and the Search for a New Cosmology of the Mind*]. Warszawa: Prószyński i S-ka.

Dodell-Feder, D., Koster-Hale, J., Bedny, M., & Saxe, R. (2011). fMRI item analysis in a theory of mind task. *NeuroImage*, *55* (2), 705-712.

Egorova, N., Pulvermüller, F., & Shtyrov, Y. (2014). Neural dynamics of speech act comprehension: An MEG study of naming and requesting. *Brain Topography*, *27* (3), 375-392.

Fedorenko, E., Behr, M.K., & Kanwisher, N. (2011). Functional specificity for high-level linguistic processing in the human brain. *Proceedings of the National Academy of Science, USA*, *108* (39), 16428-16433.

Ferstl, E.C., Neumann, J., Bogler, C., & von Cramon, D.Y. (2008). The extended language network: A meta-analysis of neuroimaging studies on text comprehension. *Human Brain Mapping*, *29* (5), 581–593.

Fitch, T., Hauser, M., & Chomsky, N. (2005). The evolution of the language faculty: Clarifications and implications. *Cognition*, *97* (2),179-210.

Grice, H.P. (1975). Logic and conversation. In P. Cole & J.L. Morgan (Eds.), *Syntax and Semantics. Vol. 3: Speech Acts* (pp. 41-58). New York: Academic Pres.

Hagoort, P. (2013). MUC (Memory, Unification, Control) and beyond. *Frontiers in Psychology*, *4*, 1-13.

Hauser, M.D., Chomsky. N., & Tecumseh Fitch, W. (2002). The faculty of language: What is it, who has it, and how did it evolve? *Science*, *298*, 1569-1579.

Hymes, D. (1972). On communicative competence. In J.B. Pride & J. Holmes (Eds.), *Sociolinguistics. Selected Readings* (pp. 269-293). Harmondsworth: Penguin.

Jackendoff, R. & Pinker, S. (2005). The nature of the language faculty and its implications for evolution of language. *Cognition*, *97* (2), 211-225.

Kurcz, I. (1993). Psycholingwistyka [Psycholinguistics]. In I. Kurcz (Ed.), *Psychologia a semiotyka. Pojęcia i zagadnienia* [*Psychology and Semiotics. Concepts and Issues*] (pp. 25-46). Warszawa: Zakład Semiotyki Logicznej Uniwersytetu Warszawskiego.

Kurcz, I. (2005). *Psychologia języka i komunikacji* [*Psychology of Language and Communication*]. Warszawa: Wydawnictwo Naukowe Scholar.

Mather, M., Cacioppo, J.T., & Kanwisher, N. (2013). How fMRI can inform cognitive theories. *Perspectives on Psychological Science*, *8* (1),108-113.

Milligan, K., Astington, J.W., & Dack, L.A. (2007). Language and Theory of Mind: Meta-analysis of the relation between language ability and false-belief understanding. *Child Development*, *78* (2), 622-646.

Levinson, S. (2000). *Presumptive Meaning: The Theory of Generalized Conversational Implicature*. Cambridge MA: The MIT Press.

Mahy, C., Moses, L., & Pfeifer, J. (2014). How and where: Theory-of-mind in the brain. *Developmental Cognitive Neuroscience*, *9*, 68–81.

Mather, M., Cacioppo, J.T., & Kanwisher, N. (2013). Introduction to the special section: 20 years of fMRI – What has it done for understanding cognition? *Perspectives on Psychological Science*, *8* (1), 41-43.

Meltzoff, A.N. (2007). "Like me": A foundation for social cognition. *Developmental Science*, *10* (1), 126-134.

Olineck, K.M. & Poulin-Dubois, D. (2007). Imitation of intentional actions and internal state language in infancy predict preschool theory of mind skills. *European Journal of Developmental Psychology*, *4* (1), 14-30.

van Overwalle, F. & Baetens, K. (2009). Understanding others' actions and goals by mirror and mentalizing systems: A meta-analysis. *NeuroImage*, *48* (3), 564-584.

Pinker, S. & Jackendoff, R. (2005). The faculty of language: What's special about it? *Cognition*, *95* (2), 201-236.

Varley, R., Siegal, M., & Want, S. (2001). Severe impairment in grammar does not preclude theory of mind. *Neurocase*, *7* (6), 489-493.

de Villiers, J. (2002). Complements to cognition: A longitudinal study of the relationship between complex syntax and false-belief-understanding. *Cognitive Development*, *17* (1), 1037-1060.

de Villiers, J. (2007). The interface of language and theory of mind. *Lingua*, *117* (11), 1858-1878.